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U.S. ENVIRONMENTAL PROTECTION AGENCY

Office of Radiation Programs

INTERNATIONAL NUMERICAL MULTIPLE AND SUBMULTIPLE PREFIXES

Multiples and submultiples	Prefixes	Symbols	Pronunciations
10^{12}	tera	T	tĕr'a
10^{9}	giga	G	jĭ'ga
10^{6}	mega	M	mĕg'a
10^{3}	kilo	k	kĭ'lo
10^{2}	hecto	h	hĕk'to
10	deka	da	dĕk'a
10^{-1}	deci	d	dĕs'i
10^{-2}	centi	c	sĕn'ti
10^{-3}	milli	m	mĭl'i
10^{-6}	micro	μ	mi'kro
10^{-9}	nano	n	năn'o
10^{-12}	pico	p	pē'ko
10^{-15}	femto	f	fĕm'to
10^{-18}	atto	a	ăt'to

SYMBOLS, UNITS, AND EQUIVALENTS

Symbol	Unit	Equivalent
Å	angstrom	10^{-10} meter
A	ampere(s)	
a	annum, year	
BeV	billion electron volts	GeV
Ci	curie	3.7×10^{10} dps-2.22×10^{12} dpm
cpm	counts per minute	
dpm	disintegrations per minute	
dps	disintegrations per second	
eV	electron volt	1.6×10^{-12} ergs
g	gram(s)	3.527×10^{-2} ounces= 2.205×10^{-3} pounds
Hz	hertz	cycle per second
kVp	kilovolt peak	
m	meter(s)	39.4 inches
m^3	cubic meter(s)	
mCi/mi^2	millicuries per square mile	0.386 nCi/m^2 (mCi/km^2)
mi	mile(s)	
ml	milliliter(s)	
nCi/m^2	nanocuries per square meter	2.59 mCi/mi^2
R	roentgen	
rad	unit of absorbed radiation dose	100 ergs/g
s	second	

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RADIATION DATA AND REPORTS

Volume 14, Number 7, July 1973

Radiation Data and Reports, a monthly publication of the Environmental Protection Agency presents data and reports provided by Federal, State, and foreign governmental agencies, and other cooperating organizations. Pertinent original data and interpretive manuscripts are invited from investigators.

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis, and interpretation of data on environmental radiation levels. This responsibility was delegated to the Bureau of Radiological Health, Public Health Service. Pursuant to the Reorganization Plan No. 3 of 1970, effective December 2, 1970, this responsibility was transferred to the Radiation Office of the Environmental Protection Agency which was established by this reorganization.

The Federal agencies listed below appoint their representatives to a Board of Editorial Advisors. Members of the Board advise on general publications policy; secure appropriate data and manuscripts from their agencies; and review those contents which relate to the special functions of their agencies.

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CONTENTS

Page

REPORTS

Results of a Survey of Diagnostic and Therapeutic X-ray Machines, Suffolk County, New York, 1972 ---- 397

Seymour Becker

DATA

SECTION 1. MILK AND FOOD ---- 401

Milk Surveillance, March 1973 ---- 401

Raw Milk Sampling in South Carolina, October 1971 Through February 1973 ---- 410

Milk Surveillance Network, January 1973, *NERC-LV* ---- 413

Food and Diet Surveillance ---- 417

Radionuclides in Institutional Diet Samples, April–June 1972, *EPA and FDA* ---- 417

SECTION II. WATER ---- 420

Gross Radioactivity in Surface Waters of the United States, January 1969–December 1970 ---- 421

CONTENTS—continued

	Page
Tritium Surveillance System, January–March 1973	439
Water Surveillance Programs, January 1973, *NERC-LV*	443
SECTION III. AIR AND DEPOSITION	448
Radioactivity in Airborne Particulates and Precipitation	448
1. Radiation Alert Network, March 1973	449
2. Canadian Air and Precipitation Monitoring Program, March 1973	451
3. Pan American Air Sampling Program, March 1973, *PAHO and EPA*	452
4. California Air Sampling Program, March 1973	452
Air Surveillance Network, March 1973, *NERC-LV*	454
SECTION IV. OTHER DATA	457
Environmental Levels of Radioactivity at Atomic Energy Commission Installations	457
1. Paducah Plant, January–December 1971	457
Reported Nuclear Detonations, June 1973	462
Synopses	iii
Guide for Authors	Inside back cover

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U.S. ENVIRONMENTAL PROTECTION AGENCY

Robert W. Fri, Acting Administrator

SYNOPSES

Synopses of reports, incorporating a list of key words, are furnished below in reference card format for the convenience of readers who may wish to clip them for their files.

RESULTS OF A SURVEY OF DIAGNOSTIC AND THERAPEUTIC X-RAY MACHINES, SUFFOLK COUNTY, NEW YORK, 1972. *Seymour Becker. Radiation Data and Reports,* Vol. 14, July 1973, pp. 397–400.

An investigation was conducted in Suffolk County, N.Y. to determine the number of diagnostic and therapeutic x-ray machines that were in violation of the New York State Ionizing Radiation Regulation. An x-radiation inspection in 1962 had found that approximately 75 percent did not comply. The followup survey in 1972 found that about 37 percent did not comply. This demonstrates that with careful supervision by a local health unit and cooperation by the professional practitioners, progress can be made to reduce the x-radiation exposure to the public.

KEYWORDS: Dental x ray, medical x ray, therapeutic x ray, Suffolk County, N.Y.

Reports

Results of a Survey of Diagnostic and Therapeutic X-ray Machines, Suffolk County, New York, 1972

Seymour Becker[1]

An investigation was conducted in Suffolk County, N.Y., to determine the number of diagnostic and therapeutic x-ray machines that were in violation of the New York State Ionizing Radiation Regulation. An x-radiation inspection in 1962 had found that approximately 75 percent did not comply. The follow up survey in 1972 found that about 34 percent did not comply. This demonstrates that with careful supervision by a local health unit and cooperation by the professional practitioners, progress can be made to reduce the x-radiation exposure to the public.

In 1962, the Suffolk County Health Department established a full time Radiation Control Unit to implement the requirements of the ionizing radiation section of the New York State Sanitary code, Statutory Authority: Public Health Law 225.

The Radiation Control Unit is responsible for the evaluation and control of x-radiation-producing equipment that may be a health hazard to the public. The code requires that owners of diagnostic and therapeutic x-ray machines register their equipment with the Suffolk County Health Department; also, that the Department shall inspect the apparatus for full compliance with the New York State regulations.

Although intensive effort has been made periodically by the department to publicize the radiation control program, approximately 80 percent of those x-ray machines registered were located through a time-consuming procedure of letter writing, telephone calls, and checking the telephone directory. Many of the owners of the x-ray units claimed ignorance of the registration requirement or were indifferent to the program. Therefore, a number of x-ray machines are being installed or are in use without the department's knowledge. Eventually, over a period of time, possibly years, these machines will be located by representatives of the Radiation Control Unit.

Daily, many people in Suffolk County who visit a physician, dentist, chiropractor, podiatrist, osteopath, dermatologist, or hospital, are being x-rayed when prescribed by the professional practitioners. The public appears to be confident that the x-ray equipment when energized will not create a health hazard and that the operator is licensed where required.

Our survey has shown, however, that many owners and operators of the apparatus do not know if the x-ray machine is functioning according to regulatory requirements. Consequently, the patient, the doctor's office staff, and the operator often are unsuspectingly being exposed to unwanted radiation.

During routine inspections of x-ray machines, the most common examples of needless radiation exposure were found to be attributed to (a) lack of training or inadequate training of the operators, (b) noncomplying x-ray machines, (c) inadequate protective shielding for the operators, and (d) lack of concern of the operators for good x-ray protection procedures.

Some outstanding examples of needless exposure that were observed or reported during announced or unannounced visits to x-ray facilities are:

(a) Where fixed cones are used, some opera-

[1] Mr. Becker is chief, Radiation Control Unit, Division of Environmental Health, Suffolk County Department of Health, Smithtown, N.Y.

tors do not interchange the multiple cones to reduce the x-ray beam to the area of clinical interest. In several instances, the cones are available for the announced inspection, but on unannounced visits improper oversized cones or none at all were used during x-ray examinations.

(b) Where a manual variable collimator is used with a light localizer attached, some operators do not adjust the collimating device to reduce the x-ray beam to the area of relative dimensions of the film.

(c) Dental assistants have reported that some dentists remove the dental collimator after the inspection. The reason given is that to position the x-ray tube head accurately before taking the x ray is time consuming.

(d) Some dentists who operate conventional x-ray machines use the same x-ray unit for cephalometric x-ray examinations. The techniques used for cephalometric x-ray diagnosis require a larger x-ray beam at a greater distance. The operator unknowingly uses the same collimating device for both the conventional and cephalometric examination.

(e) Many x-ray machines inspected had inadequate filtration or no added filtration at the tube port. In some instances, when an x-ray tube head is returned after servicing, the filters were missing.

(f) Many fluoroscopic x-ray machines had inadequate shutters. The x-ray beam was emitting beyond the fluoroscopic screen. Where x-ray units were converted to use image intensifiers, the shutters were not properly adjusted to the input phosphor of the device.

(g) Some fluoroscopic equipment had malfunctioning timers. Therefore, the fluoroscopist was not aware of the length of time spent during fluoroscopy. Old equipment was sold and resold with the faulty component.

(h) Fluoroscopic x-ray rooms were not darkened adequately; therefore, the light in the room interfered with the fluoroscopic examination. To compensate, the milliamperage would have to be increased producing more x rays.

(i) Some operators permit an assistant to hold a patient during an x-ray examination. In some instances, the same person is required to hold the patient for each x ray taken without wearing protective shielding.

Tables 1 through 6 contain the findings of a survey that was conducted during 1972 in Suffolk County, N.Y., to determine the number of diagnostic and therapeutic x-ray machines used in hospitals, medical, dental, chiropractic, and podiatric x-ray facilities that were not in full compliance with Part 16, Ionizing Radiation of the New York State Sanitary Code.

Table 1. Results of x-ray machine inspections Suffolk County, N.Y., 1972

Results and types of violations	Total
X-ray machines inspected [a]	1,411
X-ray machines in violation [b]	479
X-ray machines corrected [c]	368
Types of violations:	
Inadequate collimation	260
Inadequate filtration	183
Operator cannot stand 6 feet away (dental, medical, portable)	76
Inadequate protective shielding for operator	45
Inadequate shutters (fluoroscope)	32
Inadequate timer (fluoroscope)	35
Control used by operator outside a shielded area	24
Light leaks (fluoroscope)	14
Unlicensed x-ray technician (medical, dental, cephalometric)	18
Inadequate apron and gloves (fluoroscope)	9
Inadequate operating procedures	8

[a] Thirty-four percent of the x-ray machines did not comply fully with Part 16, Ionizing Radiation of the New York State Sanitary Code.
[b] Seventy-seven percent of those x-ray machines in violation are presently in full compliance of the Code.
[c] Some x-ray machines inspected had multiple violations.

When the Radiation Control Program started in 1962, approximately 75 percent of the x-ray machines surveyed did not meet the code requirements. The 1972 survey shows that only 34 percent do not comply. This demonstrates that with careful supervision and cooperation by the professional practitioners, progress can be made to reduce the radiation exposure to the public.

To further meet that goal, the following radiation protective measures are recommended:

(a) Each owner or operator of an x-ray machine should be required to obtain and display a certificate indicating that his competence in radiation protection is certified. This certificate should also extend to the inspectors of the x-ray equipment.

(b) No x-ray equipment should be installed unless the owner shows evidence of certification.

(c) Plans for new or relocated x-ray facilities should be reviewed by a regulatory agency.

Table 2. Results of x-ray surveys in hospitals (diagnostic and therapeutic x-ray machines)

Results and types of violations	Type of x-ray unit							Total
	Radiographic	Dental	Fluoroscopic	Photofluoroscopic	Combination radiographic and fluoroscopic	Therapy	Portable	
X-ray machines inspected	31	6	1	1	29	7	24	99
X-ray machines in violation[a]	18	2	1	1	22	3	15	62
X-ray machines corrected[b]	12	2	1	1	17	2	14	49
Types of violations:[c]								
Inadequate filtration	7	2			1		8	18
Inadequate collimation	9	1					5	15
Inadequate shielding	8			1	1	2		12
Inadequate reset timer			1		12			13
Inadequate shutters					9			9
Cable (attached to the exposure switch) less than 6 feet from the x-ray machine		1					7	8
Control operable outside a shielded area	1				4			5
Light leaks					5			5
Inadequate operating procedures	1						1	2
Inadequate interlock						1		1

[a]Sixty-three percent of the x-ray machines did not comply fully with Part 16, Ionizing Radiation of the New York State Sanitary Code.
[b]Seventy-nine percent of those x-ray machines in violation are presently in full compliance of the Code.
[c]Some of the x-ray machines inspected had multiple violations.

Table 3. Results of medical x-ray machine surveys (diagnostic and therapeutic)

Results and types of violations	Type of x-ray unit					Total
	Radiographic	Fluoroscopic	Combination radiographic and fluoroscopic	Therapy	Portable	
X-ray machines inspected						193
X-ray machines in violation[a]						98
X-ray machines corrected[b]						55
Types of violations:[c]						
Inadequate collimation	25		25	1		51
Inadequate filtration	13	4	15			32
Inadequate shielding	14		11			25
Inadequate shutters		7	16			23
Inadequate reset timer		3	19			22
Control used by operator outside a shielded area	10		7			17
Light leaks		2	7			9
Inadequate operating procedures			2	1		3
Inadequate apron and gloves		2	1			3
Unlicensed x-ray technician	3					3
Tube to panel distance less than 12 inches		1				1
Personnel monitoring required			1			1

[a]Fifty-one percent of the x-ray machines did not comply fully with Part 16, Ionizing Radiation of the New York State Sanitary Code.
[b]Fifty-six percent of those x-ray machines in violation are presently in full compliance of the Code.
[c]Some of the x-ray machines inspected had multiple violations.

(d) X-ray machines should be registered with a regulatory agency.

(e) New or relocated x-ray machines should be inspected prior to use.

(f) Operation of x-ray machines should be temporarily suspended until violations are corrected and reinspected. If this causes a hardship to the operator (no other unit available in an emergency), then limited use should be permitted and a time scheduled for corrective action.

(g) Routine inspections and calibrations of x-ray machines should be conducted by certified radiation specialists.

(h) Regulatory agencies should issue a compliance certificate to be posted in the x-ray facility.

Table 4. Results of dental x-ray machine surveys

Results and types of violations	Total
X-ray machines inspected	1,003
X-ray machines in violation [a]	250
X-ray machines corrected [b]	235
Types of violations, conventional x-ray machines: [c]	
Inadequate filtration	115
Inadequate collimation	82
Cable (attached to the exposure switch) less than 6 feet from the x-ray machine	65
Types of violations, cephalometric x-ray machines: [d]	
Inadequate collimation (32 out of 40 cephalometric x-ray machines did not have adequate collimation)	32
Unlicensed x-ray technicians	15

[a] Twenty-five percent of the x-ray machines did not comply fully with Part 16, Ionizing Radiation, of the New York State Sanitary Code.
[b] Ninety-four percent of those x-ray machines in violation are presently in full compliance of the Code.
[c] Some of the x-ray machines inspected had multiple violations.
[d] Some dentists who operate conventional x-ray machines use the same x-ray unit for cephalometric x-ray examinations. The technique used for cephalometric x-ray diagnosis requires a larger x-ray beam at a greater distance. The dentist unknowingly uses the same collimating device for both the conventional and cephalometric examinations.

Table 5. Results of chiropractic x-ray machine surveys

Results and types of violations	Total
X-ray machines inspected	54
X-ray machines in violation [a]	37
X-ray machines corrected [b]	23
Types of violations: [c]	
Inadequate collimation	37
Inadequate shielding	8
Inadequate filtration	5
Control used by operator outside a shielded area	2

[a] Sixty-nine percent of the x-ray machines did not comply fully with Part 16, Ionizing Radiation, of the New York State Sanitary Code.
[b] Sixty-two percent of those x-ray machines in violation are presently in full compliance with the code.
[c] Some of the x-ray machines inspected had multiple violations.

Table 6. Results of podiatry x-ray machine surveys

Results and types of violations	Total
X-ray machines inspected	62
X-ray machines in violation [a]	49
X-ray machines corrected [b]	38
Types of violations: [c]	
Inadequate collimation	43
Inadequate filtration	13
Cable (attached to the exposure switch) less than 6 feet from the x-ray machine	3
Unlicensed x-ray technician	2

[a] Seventy-nine percent of the x-ray machines did not comply fully with Part 16, Ionizing Radiation of the New York State Sanitary Code.
[b] Seventy-eight percent of those x-ray machines in violation presently are in full compliance of the code.
[c] Some of the x-ray machines inspected had multiple violations.

In summary, there is a need for an x-ray inspection program enforced by a regulatory agency. Also, radiation doses administered to the public each day could be reduced considerably with no decrease in the number of x-rays or the amount of diagnostic information, if properly trained and licensed operators would use fast film, maintain up-to-date techniques, and routinely have their x-ray machines inspected. Most important, the public must be instructed to demand that the x-ray machines and operators comply with the radiation protection rules and regulations.

SECTION I. MILK AND FOOD

Milk Surveillance, March 1973

Although milk is only one of the sources of dietary intake of environmental radioactivity, it is the food item that is most useful as an indicator of the general population's intake of radionuclide contaminants resulting from environmental releases. Fresh milk is consumed by a large segment of the population and contains several of the biologically important radionuclides that may be released to the environment from nuclear activities. In addition, milk is produced and consumed on a regular basis, is convenient to handle and analyze, and samples representative of general population consumption can be readily obtained. Therefore, milk sampling networks have been found to be an effective mechanism for obtaining information on current radionuclide concentrations and long-term trends. From such information, public health agencies can determine the need for further investigation or corrective public health action.

The Pasteurized Milk Network (PMN) sponsored by the Office of Radiation Programs, Environmental Protection Agency, and the Office of Food Sanitation, Food and Drug Administration, Public Health Service, consists of 63 sampling stations: 61 located in the United States, one in Puerto Rico, and one in the Canal Zone. Many of the State health departments also conduct local milk surveillance programs which provide more comprehensive coverage within the individual State. Data from 16 of these State networks are reported routinely in *Radiation Data and Reports*. Additional networks for the routine surveillance of radioactivity in milk in the Western Hemisphere and their sponsoring organizations are:

Pan American Milk Sampling Program (Pan American Health Organization and U.S. Environmental Protection Agency)—5 sampling stations

Canadian Milk Network (Radiation Protection Division, Canadian Department of National Health and Welfare)—16 sampling stations.

The sampling locations that make up the networks presently reporting in *Radiation Data and Reports* are shown in figure 1. Based on the similar purpose for these sampling activities, the present format integrates the complementary data that are routinely obtained by these several milk networks.

Radionuclide and element coverage

Considerable experience has established that relatively few of the many radionuclides that are formed as a result of nuclear fission become incorporated in milk (*1*). Most of the possible radiocontaminants are eliminated by the selective metabolism of the cow, which restricts gastrointestinal uptake and secretion into the milk. The five fission-product radionuclides which commonly occur in milk are strontium-89, strontium-90, iodine-131, cesium-137, and barium-140. A sixth radionuclide, potassium-40, occurs naturally in 0.0118 percent (*2*) abundance of the element potassium, resulting in a specific activity for potassium-40 of 830 pCi/g total potassium.

Two stable elements, which are found in milk, calcium and potassium, have been used as a means for assessing the biological behavior of metabolically similar radionuclides (ra-

Figure 1. Milk sampling networks in the Western Hemisphere

diostrontium and radiocesium, respectively). The contents of both calcium and potassium in milk have been measured extensively and are relatively constant. Appropriate values and their variations, expressed in terms of 2 standard deviations (2σ), for these elements are 1.16 ± 0.08 g/liter for calcium and 1.15 ± 0.21 g/liter for potassium. These figures are averages of data from the PMN for May 1963–March 1966 (*3*) and are used for general radiation calculations.

Accuracy of data from various milk networks

In order to combine data from the international, national, and State networks considered in this report, it was first necessary to determine the accuracy with which each laboratory is making its determinations and the agreement of the measurements among the laboratories. The Analytical Quality Control Service of the Office of Radiation Programs conducts periodic studies to assess the accuracy of determinations of radionuclides in milk performed by interested radiochemical laboratories. The generalized procedure for making such a study has been outlined previously (*4*).

The most recent study was conducted during June 1972 with 37 laboratories participating in an experiment on a milk sample containing known concentrations of iodine-131, cesium-137, strontium-89, and strontium-90 (*5*). Of the 18 laboratories producing data for the network reports in *Radiation Data and Reports*, 14 participated in the study.

The accuracy results of this study for these 14 laboratories are shown in table 1. The accuracy of the cesium-137 measurements continues to be excellent as in previous experiments. However, both the accuracy and precision need to be improved for iodine-131, strontium-89, and strontium-90, which could probably be accomplished through recalibration.

Development of a common reporting basis

Since the various networks collect and analyze samples differently, a complete understanding of several parameters is useful for interpreting the data. Therefore, the various milk surveillance networks that report regularly were surveyed for information on analytical methods, sampling and analysis frequencies, and estimated analytical errors associated with the data.

In general, radiostrontium is collected by an ion-exchange technique and determined by beta-particle counting in low-background detectors, and the gamma-ray emitters (potassium-40, iodine-131, cesium-137, and barium-140) are determined by gamma-ray spectroscopy of whole milk. Each laboratory has its own modifications and refinements of these basic methodologies.

Many networks collect and analyze samples on a monthly basis. Some collect samples more frequently but composite the several samples for one analysis, while others carry out their analyses more often than once a month. Many networks are analyzing composite samples on a quarterly basis for certain nuclides. The frequency of collection and analysis varies not only among the networks but also at different stations within some of the networks. In addition, the frequency of collection and analysis

Table 1. Distribution of mean results, quality control experiment

Isotope and known concentration	Number of laboratories in each category				Experimental 2σ error (pCi/liter)
	Acceptable [a]	Warning level [b]	Unacceptable [c]	Total	
Iodine-131 (96 or 99 pCi/liter)	7 (54%)	1 (8%)	5 (28%)	13	6
Iodine-131 (438 or 484 pCi/liter)	11 (79%)	0	3 (21%)	14	25 or 28
Cesium-137 (53 or 54 pCi/liter)	11 (85%)	1 (8%)	1 (8%)	13	6
Cesium-137 (295 or 303 pCi/liter)	11 (79%)	2 (14%)	1 (7%)	14	17
Strontium-89 (29 or 30 pCi/liter)	10 (83%)	0	2 (17%)	12	6
Strontium-89 (197 or 201 pCi/liter)	4 (40%)	1 (10%)	5 (50%)	10	11 or 12
Strontium-90 (32.1 or 32.4 pCi/liter)	5 (38%)	4 (31%)	4 (31%)	13	1.9
Strontium-90 (150.5 or 151.2 pCi/liter)	7 (58%)	0	5 (42%)	12	8.7

[a] Measured concentration equal to or within 2σ of the known concentration.
[b] Measured concentration outside 2σ and equal to or within 3σ of the known concentration.
[c] Measured concentration outside 3σ of the known concentration.

is a function of current environmental levels. The number of samples analyzed at a particular sampling station under current conditions is reflected in the data presentation. Current levels for strontium-90 and cesium-137 are relatively stable over short periods of time, and sampling frequency is not critical. For the short-lived radionuclides, particularly iodine-131, the frequency of analysis is critical and is generally increased at the first measurement or recognition of a new influx of this radionuclide.

The data in table 2 show whether raw or pasteurized milk was collected. An analysis (*6*) of raw and pasteurized milk samples collected during January 1964 to June 1966 indicated that for relatively similar milkshed or sampling areas, the differences in concentration of radionuclides in raw and pasteurized milk are not statistically significant (*6*). Particular attention was paid to strontium-90 and cesium-137 in that analysis.

Practical reporting levels were developed by the participating networks, most often based on 2-standard-deviation counting errors or 2-standard-deviation total analytical errors from replicate analyses (*3*). The practical reporting level reflects analytical factors other than statistical radioactivity counting variations and will be used as a practical basis for reporting data.

The following practical reporting levels have been selected for use by all networks whose practical reporting levels were given as equal to or less than the given value.

Radionuclide	Practical reporting level (pCi/liter)
Strontium-89	5
Strontium-90	2
Iodine-131	10
Cesium-137	10
Barium-140	10

Some of the networks gave practical reporting levels greater than those above. In these cases, the larger value is used so that only data considered by the network as meaningful will be presented. The practical reporting levels apply to the handling of individual sample determinations. The treatment of measurements equal to or below these practical reporting levels for calculation purposes, particularly in calculating monthly averages, is discussed in the data presentation.

Analytical error or precision expressed as pCi/liter or percent in a given concentration range has also been reported by the networks (*3*). The precision errors reported for each of the radionuclides fall in the following ranges:

Radionuclide	Analytical errors of precision (2 standard deviations)
Strontium-89	1–5 pCi/liter for levels <50 pCi/liter; 5–10% for levels ≥50 pCi/liter;
Strontium-90	1–2 pCi/liter for levels <20 pCi/liter; 4–10% for levels ≥20 pCi/liter;
Iodine-131, Cesium-137, Barium-140	4–10 pCi/liter for levels <100 pCi/liter; 4–10% for levels ≥100 pCi/liter.

For iodine-131, cesium-137, and barium-140, there is one exception for these precision error ranges: 25 pCi/liter at levels <100 pCi/liter for Colorado. This is reflected in the practical reporting level for the Colorado milk network.

Federal Radiation Council guidance applicable to milk surveillance

In order to place the U.S. data on radioactivity in milk presented in *Radiation Data and Reports* in perspective, a summary of the guidance provided by the Federal Radiation Council for specific environmental conditions was presented in the February 1973 issue of *Radiation Data and Reports.*

Data reporting format

Table 2 presents the integrated results of the international, national, and State networks discussed earlier. Column 1 lists all the stations which are routinely reported in *Radiation Data and Reports.* The relationship between the PMN stations and the State stations is shown

Table 2. Concentrations of radionuclides in milk for March 1973 and 12-month period, April 1972 through March 1973

Sampling location		Type of sample [a]	Radionuclide concentration (pCi /liter)			
			Strontium-90		Cesium-137	
			Monthly average [b]	12-month average	Monthly average [b]	12-month average
UNITED STATES:						
Ala:	Montgomery [c]	P	NA	5	0	5
Alaska:	Palmer [c]	P	5	4	0	3
Ariz:	Phoenix [c]	P	NA	0	0	0
Ark:	Little Rock [c]	P	9	9	0	2
Calif:	Sacramento [c]	P	NA	1	0	0
	San Francisco [c]	P	NA	0	0	0
	Del Norte	P	11	11	12	8
	Fresno	P	0	1	0	3
	Humboldt	P	4	3	0	2
	Los Angeles	P	2	1	0	2
	Mendocino	P	0	3	0	4
	Sacramento	P	2	2	0	3
	San Diego	P	2	1	0	4
	Santa Clara	P	0	2	0	3
	Shasta	P	0	2	0	5
	Sonoma	P	0	2	0	3
Colo:	Denver [c]	P	NA	3	0	0
	East	R	NS	NA	NS	5
	Northeast	R	NS	NA	NS	1
	Northwest	R	NA	NA	[d] 0	0
	South Central	R	NS	NS	NS	NS
	Southeast	R	NS	NA	NS	0
	Southwest	R	NA	NA	[d] 0	2
	West	R	NA	NA	[d] 0	3
Conn:	Hartford [c]	P	NA	5	0	4
	Central	P	NA	6	0	12
Del:	Wilmington [c]	P	NA	8	0	8
D.C:	Washington [c]	P	NA	6	0	3
Fla:	Tampa [c]	P	5	4	17	33
	Central	R	6	5	0	38
	North	R	8	7	12	13
	Northeast	R	6	5	0	30
	Southeast	R	7	5	30	43
	Tampa Bay area	P	6	5	18	33
	West	R	9	8	0	11
Ga:	Atlanta [c]	P	NA	9	13	9
Hawaii:	Honolulu [c]	P	0	2	0	1
Idaho:	Idaho Falls [c]	P	5	4	0	0
Ill:	Chicago [c]	P	5	5	0	6
Ind:	Indianapolis [c]	P	NA	5	0	1
	Central	P	8	7	15	9
	Northeast	P	5	6	10	9
	Northwest	P	6	8	10	11
	Southeast	P	5	7	10	7
	Southwest	P	6	7	10	10
Iowa:	Des Moines [c]	P	NA	4	0	0
	Iowa City	R	6	7	0	6
	Des Moines	P	5	6	0	3
	Little Cedar	R	NS	4	0	3
	Spencer	R	5	6	0	4
Kans:	Wichita [c]	P	NA	6	0	0
	Coffeyville	P	NA		0	9
	Dodge City	P	NA		0	6
	Falls City, Nebr	P	NA		0	7
	Hays	P	NA		0	7
	Kansas City	P	NA		11	3
	Topeka	P	NA		0	6
	Wichita	P	NA		0	5
Ky:	Louisville [c]	P	NA	7	0	3
La:	New Orleans [c]	P	11	11	0	2
Maine:	Portland [c]	P	NA	6	12	20
Md:	Baltimore [c]	P	NA	6	0	5
Mass:	Boston [c]	P	6	6	0	13
Mich:	Detroit [c]	P	NA	7	0	5
	Grand Rapids [c]	P	NA	7	0	3
	Bay City	P	5	4	0 (2)	3
	Charlevoix	P	7	4	3 (5)	7
	Detroit	P	4	4	0	4
	Grand Rapids	P	11	4	0	7
	Lansing	P	7	4	0 (2)	6
	Marquette	P	5	5	0 (2)	13
	Monroe	P	9	3	0 (2)	3
	South Haven	P	9	5	3 (4)	7
Minn:	Minneapolis [c]	P	NA	7	0	11
	Bemidji	P	5	6	0	15
	Duluth	P	15	14	18	28
	Fergus Falls	P	5	7	0	11
	Little Falls	P	15	17	16	38
	Mankato	P	5	5	0	11
	Marshall	P	4	3	0	0

See footnotes at end of table.

Table 2. Concentrations of radionuclides in milk for March 1973 and 12-month period, April 1972 through March 1973—continued

Sampling location		Type of sample [a]	Radionuclide concentration (pCi /liter)			
			Strontium-90		Cesium-137	
			Monthly average [b]	12-month average	Monthly average [b]	12-month average
UNITED STATES:						
Minn:	Minneapolis	P	10	9	12	11
	Rochester	P	6	7	0	0
Miss:	Jackson *	P	NA	9	11	8
Mo:	Kansas City *	P	NA	5	0	1
	St. Louis *	P	NA	6	0	1
Mont:	Helena *	P	NA	4	0	0
Nebr:	Omaha *	P	NA	5	0	0
Nev:	Las Vegas *	P	NA	1	0	0
N.H:	Manchester *	P	NA	7	12	14
N.J:	Trenton *	P	NA	7	0	5
N. Mex:	Albuquerque *	P	NA	1	0	0
N.Y:	Buffalo *	P	4	5	11	4
	New York City *	P	NA	8	0	5
	Syracuse *	P	NA	6	0	4
	Albany	P	4	4	17 (2)	0
	Buffalo	P	6	5	11	0
	Massena	P	NS	7	NS	0
	New York City	P	8	6	14	0
	Syracuse	P	5	5	NA	0
N.C:	Charlotte *	P	NA	8	0	5
N. Dak:	Minot *	P	NA	9	0	3
Ohio:	Cincinnati *	P	NA	5	0	3
	Cleveland *	P	NA	6	0	4
Okla:	Oklahoma City *	P	NA	5	0	1
Oreg:	Portland *	P	4	4	0	3
	Baker	P	NA		0	2
	Coos Bay	P	NA		13	6
	Eugene	P	NA		0	0
	Medford	P	NA		11	8
	Portland composite	P	NA		0	2
	Portland local	P	NA		0	1
	Redmond	P	NA		0	2
	Tillamook	R	NA		12	11
Pa:	Philadelphia *	P	NA	6	0	4
	Pittsburgh *	P	NA	8	12	7
	Dauphin	P	NA	4	0	6
	Erie	P	7	6	0	3
	Philadelphia	P	3	5	0	5
	Pittsburgh	P	3	7	0	7
R.I:	Providence *	P	NA	6	11	11
S.C:	Charleston *	P	5	8	0	9
	Chapin	R	NS	8	NS	14
	Clemson	R	NS	7	NS	8
	Columbia	R	NS	7	NS	11
	Fairfield	R	NS	6	NS	18
	Hartsville (02)	R	7	6	NA	11
	Hartsville (03)	R	NS	17	NS	18
	Lee County	R	7	8	NA	18
	Oconee County	R	NS	8	NS	12
	Pickens	R	NS	7	NS	13
	Williston	R	NS	7	NS	15
	Winnsboro	R	NA	9	NA	30
S. Dak:	Rapid City *	P	NA	5	0	1
Tenn:	Chattanooga *	P	NA	8	0	6
	Memphis *	P	NA	7	0	1
	Chattanooga	P	6	9	0	8
	Clinton	R	5	8	12	11
	Fayetteville	R	6	8	0 (2)	7
	Kingston	R	5	8	0 (2)	4
	Knoxville	P	4	7	0 (2)	5
	Lawrenceburg	R	5	6	12	8
	Nashville	P	NS	8	NS	6
	Pulaski	R	8	6	0	7
	Sequoyah	R	NS	7	NS	13
Tex:	Austin *	P	NA	2	0	0
	Dallas *	P	NA	5	0	0
	Amarillo	R	NA		NA	
	Corpus Christi	R	NA		NA	
	El Paso	R	NA		NA	
	Fort Worth	R	NA		NA	
	Harlingen	R	NA		NA	
	Houston	R	NA		NA	
	Lubbock	R	NA		NA	
	Midland	R	NA		NA	
	San Antonio	R	NA		NA	
	Texarkana	R	NA		NA	
	Uvalde	R	NA		NA	
	Wichita Falls	R	NA		NA	
Utah:	Salt Lake City *	P	3	3	0	2
Vt:	Burlington *	P	NA	5	0	8

See footnotes at end of table.

Table 2. Concentrations of radionuclides in milk for March 1973 and 12-month period, April 1972 through March 1973—continued

Sampling location	Type of sample [a]	Radionuclide concentration (pCi/liter)			
		Strontium-90		Cesium-137	
		Monthly average [b]	12-month average	Monthly average [b]	12-month average
UNITED STATES:					
Va: Norfolk [c]	P	NA	6	0	6
Wash: Seattle [c]	P	NA	3	0	1
Spokane	P	NA	4	0	3
Benton County	R	0	1	0	0
Franklin County	R	NS	1	NS	0
Longview	R	4	4	0	1
Sandpoint, Idaho	R	6	7	0	6
Skagit County	R	5	7	0	4
W. Va: Charleston [c]	P	NA	7	0	5
Wisc: Milwaukee [c]	P	NA	5	0	5
Wyo: Laramie [c]	P	NA	2	0	0
CANADA:					
Alberta: Calgary	P	4	6	5	12
Edmonton	P	5	6	16	18
British Columbia: Vancouver	P	5	7	11	19
Manitoba: Winnipeg	P	5	5	13	14
New Brunswick: Moncton	P	6	—	9	8
Newfoundland: St. John's	P	10	17	16	22
Nova Scotia: Halifax	P	7	8	7	13
Ontario: Ottawa	P	5	6	7	8
Sault Ste. Marie	P	9	10	19	20
Thunder Bay	P	8	9	15	17
Toronto	P	3	4	3	8
Windsor	P	2	3	6	7
Quebec: Montreal	P	5	6	7	9
Quebec	P	8	8	10	17
Saskatchewan: Regina	P	6	6	15	10
Saskatoon	P	5	6	11	11
CENTRAL AND SOUTH AMERICA:					
Canal Zone: Cristobal [c]	P	NA	1	35	16
Chile: Santiago	P	0	1	0	1
Colombia: Bogota	P	0	0	0 (2)	0
Ecuador: Guayaquil	P	0	0	0	0
Jamaica: Kingston	P	NS	2	NS	49
Puerto Rico: San Juan [c]	P	NA	1	0	2
Venezuela: Caracas	P	NS	1	NS	0
PMN network average [e]		5	5	2	4

[a] P, pasteurized milk.
R, raw milk.

[b] When an individual sampling result was equal to or less than the practical reporting level, a value of "0" was used for averaging. Monthly averages less than the practical reporting level reflect the fact that some but not all of the individual samples making up the average contained levels greater than the practical reporting level. When more than one analysis was made in a monthly period, the number of samples in the monthly average is given in parentheses.

[c] Pasteurized Milk Network station. All other sampling locations are part of the State or National network.

[d] The practical reporting level for this network differs from the general ones given in the text. Sampling results for these networks were equal to or less than the following practical reporting levels:
Cesium-137: Colorado—25 pCi/liter

[e] This entry gives the average radionuclide concentrations for the Pasteurized Milk Network stations denoted by footnote [c].
NA, no analysis.
NS, no sample collected.

in figure 2. The first column in table 2 under each of the reported radionuclides gives the monthly average for the station and the number of samples analyzed in that month in parentheses. When an individual sampling result is equal to or below the practical reporting level for the radionuclide, a value of zero is used for averaging. Monthly averages are calculated using the above convention. Averages which are equal to or less than the practical reporting levels reflect the presence of radioactivity in the some of the individual samples greater than the practical reporting level.

The second column under each of the radio-

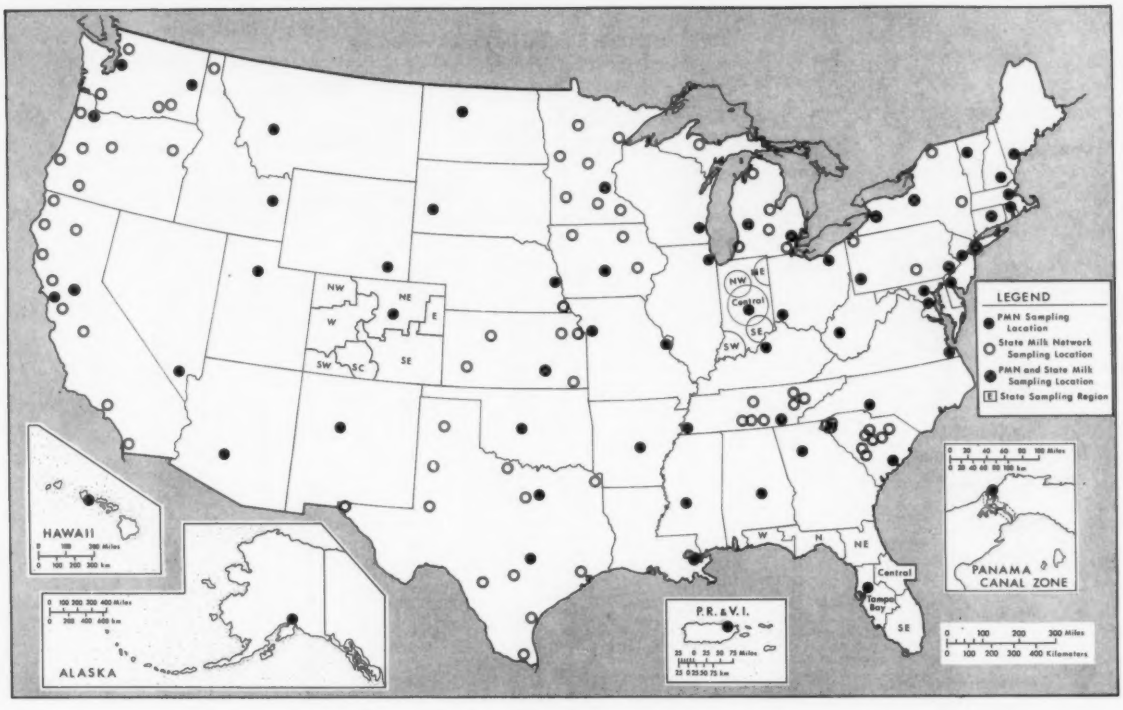

Figure 2. State and PMN sampling stations in the United States

nuclides reported gives the 12-month average for the station as calculated from the preceding 12 monthly averages, giving each monthly average equal weight. Since the daily intake of radioactivity by exposed population groups, averaged over a year, constitutes an appropriate criterion for the case where the FRC radiation protection guides apply, the 12-month average serves as a basis for comparison.

Discussion of current data

In table 2, surveillance results are given for strontium-90 and cesium-137 for March 1973 and the 12-month period, April 1972 to March 1973. Except where noted, the monthly average represents a single sample for the sampling station. Strontium-89, iodine-131, and barium-140 data have been omitted from table 2 since levels at the great majority of the stations for March 1973 were below the respective practical reporting levels. Barium-140 results for individual samples were all below the practical reporting level with the following exception: Kansas City, Kansas (State), 13 pCi/liter. No strontium-89 or iodine-131 was detected.

Strontium-90 monthly averages ranged from 0 to 15 pCi/liter in the United States for March 1973 and the highest 12-month average was 17 pCi/liter (Little Falls, Minn. and Hartsville, S.C.) representing 8.5 percent of the Federal Radiation Council radiation protection guide. Cesium-137 monthly averages ranged from 0 to 30 pCi/liter in the United States for March 1973, and the highest 12-month average was 43 pCi/liter (Southeast Florida) representing 1.2 percent of the value derived from the recommendations given in the Federal Radiation Council report.

Acknowledgement

Appreciation is expressed to the personnel of the following agencies who provide data from their milk surveillance networks:

Bureau of Radiological Health
Environmental Health & Consumer Protection Program
California Department of Public Health

Radiation Protection Division
Canadian Department of National Health and Welfare

Radiological Health Section
Division of Occupational and Radiological Health
Colorado Department of Health

Radiological Health Services
Division of Medical Services
Connecticut State Department of Health

Radiological and Occupational Health Section
Department of Health and Rehabilitative Services
State of Florida

Bureau of Environmental Sanitation
Division of Sanitary Engineering
Indiana State Board of Health

Division of Radiological Health
Environmental Engineering Services
Iowa State Department of Health

Radiation Control Section
Environmental Health Division
Kansas State Department of Health

Radiological Health Services
Division of Occupational Health
Michigan Department of Health

Radiation Control Section
Division of Environmental Health
State of Minnesota Department of Health

Bureau of Radiological Pollution Control
New York State Department of Environmental Conservation

Environmental Radiation Surveillance Program
Division of Sanitation and Engineering
Oregon State Board of Health

Radiological Health Section
Bureau of Environmental Health
Pennsylvania Department of Public Health

Division of Radiological Health
South Carolina State Board of Health

Radiological Health Services
Division of Preventable Diseases
Tennessee Department of Public Health

Division of Occupational Health
Environmental Health Services
Texas State Department of Health

Radiation Control Section
Division of Health
Washington Department of Social and Health Services

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Raw Milk Sampling in South Carolina, October 1971 through February 1973 [1]

Division of Radiological Health
South Carolina State Board of Health

As part of its radiological surveillance around nuclear facilities in the State, the Division of Radiological Health of the South Carolina State Board of Health, operates the Raw Milk Sampling Network (RMSN). The State RMSN presently consists of 12 locations distributed around 10 nuclear facility sites in South Carolina (figure 1).

With the cooperation of the dairyman, samples of raw milk are collected at each point from the bulk storage tank in the dairy barn. The 1-gallon sample is transported immediately to the Radiological Laboratory in Columbia for analysis. Several factors influenced the selection of RMSN stations. The major factor was the prevailing wind direction at a particular nuclear facility. The preferable sample location was identified from the published wind rose data available from the facility safety analysis reports. Selection of dairy farms was limited, however, because of economic and other reasons and these factors often resulted in sampling at the only locations available in some areas.

The RMSN involves sampling and analysis of raw milk in both preoperational and operational phases of the radiological surveillance program. The milk for all sampling stations in this report was collected quarterly in order to detect any seasonal, meteorological, or radio-

[1] This report was presented by C. Nolan Bivens, MS, Division of Radiological Health, South Carolina State Board of Health.

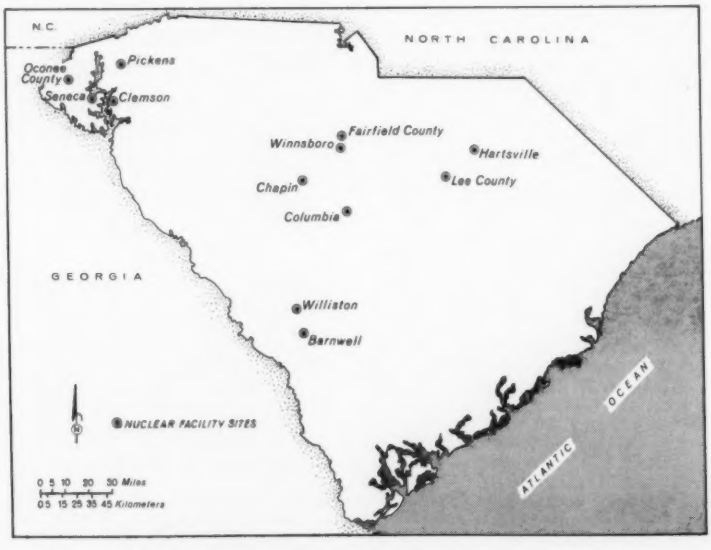

Figure 3. Raw milk sampling network stations in South Carolina

Table 1. Results of radiological analysis on raw milk collected, South Carolina, October 1971 through December 1972

Site	Station number	Number of samples	Minimum detectable activity[a]	Strontium–89 (pCi/liter)	Strontium–90 (pCi/liter)	Iodine–131 (pCi/liter)	Cesium–137 (pCi/liter)	Barium–140 (pCi/liter)
Williston	40–4014	5	Maximum	2.1	9.4		38.4	
			Minimum	1.1	7.4	ND	12.0	ND
			Average	1.4	8.1		14.4	
Barnwell	40–4015	5	Maximum	2.4	11.6		57.6	
			Minimum	.6	7.5	ND	0	ND
			Average	1.5	9.6		23.8	
Columbia	40–4030	4	Maximum	2.5	8.0		19.1	
			Minimum	1.0	7.4	ND	6.3	ND
			Average	1.6	7.6		11.8	
Lee County	40–4001	5	Maximum	2.4	10.2		21.3	
			Minimum	.3	7.8	ND	0	ND
			Average	1.4	8.6		17.6	
Hartsville	40–4002	5	Maximum	2.5	7.9		24.0	
			Minimum	.5	4.7	ND	0	ND
			Average	1.6	6.0		9.7	
Hartsville	40–4003	5	Maximum	4.0	24.5		27.0	
			Minimum	2.1	17.0	ND	0	ND
			Average	3.0	19.5		18.5	
Pickens	40–4008	4	Maximum	2.6	8.7		18.0	
			Minimum	1.5	6.5	ND	5.0	ND
			Average	2.2	7.4		11.3	
Clemson	40–4009	6	Maximum	2.5	9.9		13.2	
			Minimum	.6	7.5	ND	0	ND
			Average	1.3	8.5		7.0	
Oconee County	40–4010	3	Maximum	1.2	10.3		16.4	
			Minimum	.4	9.1	ND	8.0	ND
			Average	.7	9.6		13.3	
Winnsboro	40–4020	4	Maximum	1.7	11.8		42.7	
			Minimum	.6	9.0	ND	11.2	ND
			Average	1.1	9.8		27.9	
Fairfield	40–4021	4	Maximum	1.7	7.6		23.0	
			Minimum	.6	4.6	ND	14.6	ND
			Average	1.1	6.2		19.5	
Chapin	40–0755	4	Maximum	2.2	11.3		17.7	
			Minimum	1.3	7.6	ND	12.7	ND
			Average	1.8	9.2		15.8	

[a]The minimum detectable activity for the following radionuclides is as follows: strontium–89, 0.3 pCi/liter; strontium–90, 0.2 pCi/liter; iodine–131, 7.0 pCi/liter; cesium–137, 6.0 pCi/liter; barium–140, 7.0 pCi/liter.
ND, nondetectable activity. A value of 0 is used for averaging when the level of activity is less than the minimum detectable activity.

logical changes in an area. Records also are maintained on the size of the dairy herd, type feed, watering source, and any milk processor purchasing the raw milk.

Data are presented in table 1 for October 1971 through December 1972. Nuclear facility sites are referred to by number and may be identified on the map (figure 1). The minimum detectable activity reflects counting efficiency, chemical yields, and a 2-standard deviation counting error.

Radiostrontium is collected on an ion-exchange column, separated from radiobarium and counted using a Beckman Low Beta II gas-proportional counter. Gamma emitters are determined by scanning a 3-liter sample with a 3-inch NaI detector on a 512 channel Nuclear Data-130 system.

The Division of Radiological Health believes that the surveillance of raw milk is more meaningful than the collection and analysis of pasteurized milk in its monitoring of nuclear facilities. The South Carolina State Board of Health will continue monitoring raw milk from producers in South Carolina and will add new RMSN stations as other facilities are announced and as present facilities become operational.

The strontium-90 quarterly concentrations ranged from 4.7 to 24.5 pCi/liter for the first five quarters that the Raw Milk Sampling Network has been in operation (table 1). The highest five-quarter average is 17.0 pCi/liter (station number 40–4003) representing 7.5 percent of the Federal Radiation Council radiation protection guide. The cesium-137 quarterly concentration ranged from less than minimum

Table 2. Concentration of radionuclides in milk for January 1973 and 12-month period, February 1972 through January 1973[a]

Sampling location	Type of sample	Radionuclide concentration (pCi/liter)			
		Strontium-90		Cesium-137	
		Monthly average	12-month average	Monthly average	12-month average
South Carolina:					
Chapin-55	R	8	8	10	14
Clemson-09	R	NS	7	NS	9
Columbia-30	R	7	7	13	12
Fairfield-21	R	7	6	NA	20
Hartsville-02	R	NS	5	NS	11
Hartsville-03	R	17	17	18	19
Lee County-01	R	NS	7	NS	16
Oconee County-10	R	NS	9	NS	13
Pickens-08	R	NS	7	NS	15
Williston-14	R	NS	8	NS	16
Winnsboro-20	R	NS	9	NS	33

[a] U.S. milk surveillance data for January 1973 appears in the May 1973 issue of *Radiation Data and Reports*.
NS, no sample collected.

Table 3. Concentration of radionuclides in milk for February 1973 and 12-month period, March 1972 through February 1973[a]

Sampling location	Type of sample	Radionuclide concentration (pCi/liter)			
		Strontium-90		Cesium-137	
		Monthly average	12-month average	Monthly average	12-month average
South Carolina:					
Chapin-55	R	NS	8	NS	14
Clemson-09	R	6	6	0	8
Columbia-30	R	7	7	11	11
Fairfield-21	R	NS	6	NS	20
Hartsville-02	R	6	5	12	11
Hartsville-03	R	19	17	17	18
Lee County-01	R	NS	7	NS	16
Oconee County-10	R	NS	9	NS	13
Pickens-09	R	NS	7	NS	15
Williston-14	R	NS	8	NS	16
Winnsboro-20	R	NS	9	NS	33

[a] U.S. milk surveillance data for February 1973 appears in the June 1973 issue of *Radiation Data and Reports*.
NS, no sample collected.

detectable activity to 57.6 pCi/liter for the first five quarters that the RMSN began operations. The highest five-quarter average is 27.9 pCi/liter (station number 40–4020) representing 0.8 percent of the value derived from the Federal Radiation Council.

Table 2 gives the concentration of strontium-90 and cesium-137 in milk for January 1973 and table 3 gives the concentration for February 1973.

Two of the nuclear facilities were operational when the Raw Milk Sampling Network began. The remaining three facilities are under various stages of construction, therefore, no baseline to operational comparisons can be made.

Milk Surveillance Network, January 1973

National Environmental Research Center—
Las Vegas, Environmental Protection Agency

The National Environmental Research Center-Las Vegas (NERC-LV) is responsible for conducting radiological safety and environmental surveillance programs in the offsite area surrounding the Nevada Test Site (NTS) in support of nuclear testing conducted by the U.S. Atomic Energy Commission (AEC). When required, additional surveillance programs are established at locations other than around NTS in support of AEC operations. Beginning with the January 1972 report, the analytical results of milk samples collected for the above programs have been reported in *Radiation Data and Reports.*

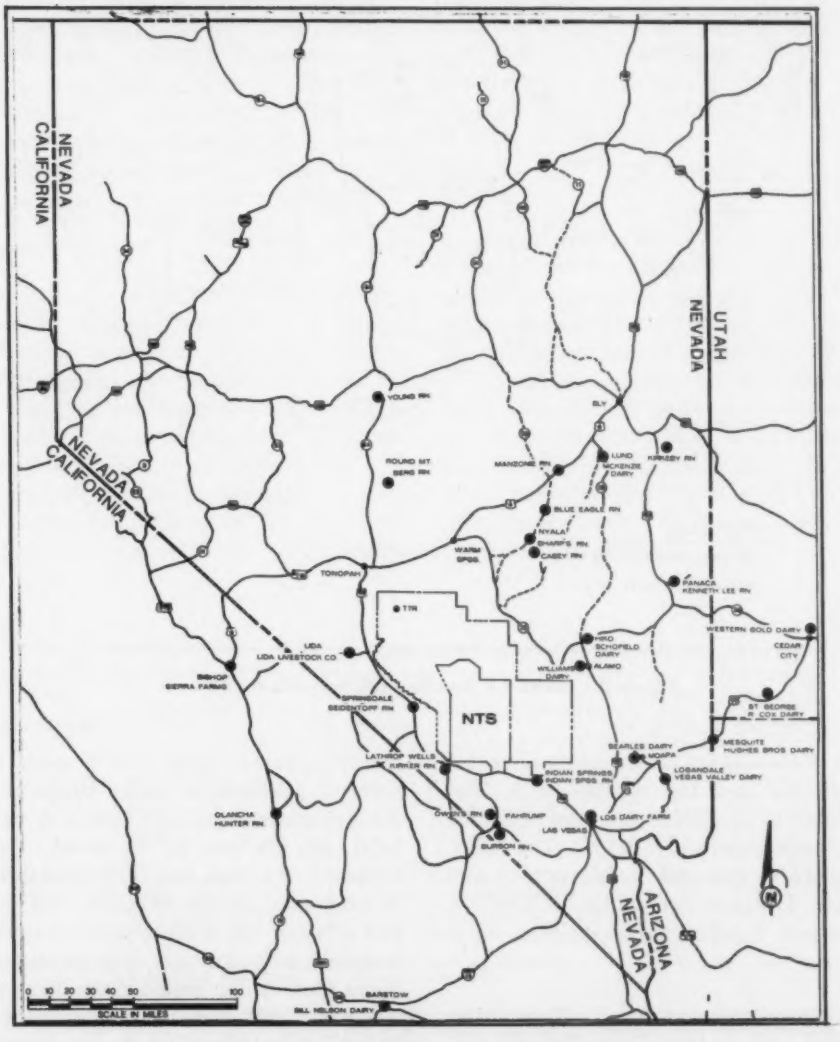

Figure 1. NERC-LV Milk Surveillance Network

Figure 2. NERC-LV Standby Milk Surveillance Network

The Milk Surveillance Networks[1] operated by the NERC-LV are the routine Milk Surveillance Network (MSN) and the Standby Milk Surveillance Network (SMSN). The MSN, shown in figure 1, consists of 24 regular and two alternate locations at which NERC-LV personnel collect 1-gallon milk samples on a monthly basis from family milk cows, commercial pasteurized milk, Grade A raw milk for pasteurization, and Grade A raw milk for local consumption. In the event of a release of radioactivity from the NTS, intensive sampling is conducted in the affected area out to about 300 miles of the NTS to determine radionuclide concentrations in milk, and to assess radiation doses that could result from the ingestion of the milk. Milk supplies and producers beyond 300 miles are sampled by the SMSN.

[1] These programs are operated under a Memorandum of Understanding (No. AT(26–1)–539) with the Nevada Operations Office, Las Vegas, Nev.

Previously, the network consisted of 32 regular and five alternate sampling locations, as described in the December 1972 issue of *Radiation Data and Reports*. A reduction of sampling locations was implemented this year to economize operations and yet provide adequate coverage in the event of a release.

The SMSN (*1*), shown in figure 2, consists of about 185 Grade A milk processing plants which can be requested by telephone to collect raw milk samples representing milksheds supplying milk to the plants. Samples from the network are collected and mailed to the NERC-LV through the cooperation of Federal, State, and local government agencies in the event of a release of radioactivity at NTS or other test locations. Periodically, one sample is collected from each station to maintain network readiness and to check the network's reliability.

Analytical procedures

All routine samples are analyzed for gamma-emitting radionuclides by gamma spectroscopy, and for radiostrontium on a quarterly basis by radiochemistry procedures. Samples collected at Las Vegas and at five locations which have often been within downwind trajectories from the NTS during tests are also analyzed for tritium. Special or event-related samples are normally gamma scanned. Further analyses depend on whether radioactivity is detected and/or on special requirements of the sampling program. During readiness checks of the SMSN, only random samples are analyzed for strontium-89, strontium-90, and tritium.

Table 1 lists the general analytical procedures and detection limits, as described by Johns (*2*), and Lem and Snelling (*3*). For gamma spectroscopy analyses, the samples are placed in 3.5-liter inverted-well Marinelli beakers. All routine samples are counted for 40 minutes. Special samples collected following known releases of activity are normally counted 20 minutes, but this will vary from 10 to 40 minutes depending on radionuclide concentration and sample workload. The activity concentration of each of the detected nuclides at the time of count is calculated and extrapolated to time of collection.

Results

The analytical results of all milk samples collected in January 1973 by the NERC-LV milk surveillance program are listed in table 2. With the exception of cesium-137 at levels near the minimum detectable activity (MDA) of 10 pCi/liter, no gamma-emitting fission products were identified by gamma spectrometry in any of the samples collected in January. Levels of tritium and strontium-90 near the MDA's for these radionuclides (≈200 PCi/liter and 1 pCi/liter, respectively) were also measured by radiochemistry analyses.

Table 1. Analytical procedures

Type of analysis	Analytical equipment	Counting period (min.)	Analytical procedures	Sample size (liter)	Detection limits (pCi/liter)
Gamma spectroscopy	Gamma spectrometer with a 10 by 10-cm NaI(Tl) crystal with input to 200 channels (0–2 MeV) of 400-channel, pulse-height analyzer.	10–40	Radionuclide concentrations quantitated from gamma spectrometer data by computer using an eight element matrix technique.	3.5	Generally 10 pCi/liter for most common fallout radionuclides in a simple spectrum.
Strontium-89, -90	Low background thin-window, gas-flow proportional counter with a 5.7 cm diameter window (80 $\mu g/cm^2$)	50	Chemical separation by ion exchange. Separated sample counted successively; activity calculated by simultaneous equations.	1.0	[a] ^{89}Sr ≈5 ^{90}Sr ≈2
Tritium	Automatic liquid scintillation counter with output printer.	100	Sample prepared by distillation.	.005	[a, b] ≈320

[a] The detection limit for a given sample is defined as that concentration which is equal to the 2-sigma counting error.

[b] The detection limit for samples analyzed during February 1972 and thereafter was ≈220 pCi/liter.

Table 2. Milk surveillance results, January 1973

Location	Date collected (1973)	Sample type [a]	Radionuclide concentrations [b] (pCi/liter)			
			^{137}Cs	^{89}Sr	^{90}Sr	^{3}H
California:						
Bishop:						
Sierra Farms	1/3	11	<10	<2.0	1.5±1.4	NA
Hinkley:						
Bill Nelson Dairy	1/3	12	<10	<2.0	<1.1	NA
Olancha:						
Hunter Ranch	1/3	13	<10	<2.0	1.7±1.2	NA
Nevada:						
Alamo:						
Williams Dairy	1/11	12	<10	<2.0	<1.3	NA
Austin:						
Young's Ranch	1/15	13	<10	<2.0	3.9±1.7	670±250
Currant:						
Blue Eagle Ranch	1/10	13	20	<2.0	2.8±1.4	NA
Mazonie Ranch	1/9	13	<10	<2.0	<1.4	NA
Hiko:						
Schofield Dairy	1/8	12	<10	<2.0	<1.3	420±240
Indian Springs:						
Indian Springs Ranch	1/11	13	<10	<1.0	<1.0	NA
Las Vegas:						
LDS Dairy Farms	1/15	12	<10	<2.0	<1.1	<250
Lathrop Wells:						
William J. Kirker	1/9	13	<10	<2.0	1.4±1.3	NA
Lida:						
Lida Livestock Co	1/14	13	<10	<2.0	<1.2	NA
Logandale:						
Vegas Valley Dairy	1/12	12	<10	<1.0	<1.0	NA
Lund:						
McKenzie Dairy	1/11	12	10	<2.0	6.1±1.6	<230
Mesquite:						
Hughes Bros. Dairy	1/8	12	10	<2.0	<1.5	320±240
Moapa:						
Searles Dairy	1/8	12	<10	<2.0	1.3±1.3	NA
Nyala:						
Sharp's Ranch	1/16	13	<10	[c] NA	[c] NA	<250
Pahrump:						
Owens Ranch	1/11	13	<10	<1.0	<1.1	NA
Panaca:						
Kenneth Lee Ranch	NS					
Round Mt:						
Russell Berg	NS					
Shoshone:						
Kirkeby Ranch	1/11	13	<10	<2.0	2.6±1.4	NA
Springdale:						
Seidentopf Ranch	1/10	13	<10	<2.0	<1.3	NA
Utah:						
Cedar City:						
Western Gold Dairy	1/9	12	<10	<2.0	5.1±1.7	NA
St. George:						
R. Cox Dairy	1/8	12	<10	<2.0	<1.5	NA

[a] 11—Pasteurized milk.
12—Raw milk from Grade A producer(s).
13—Raw milk from family cow(s).
[b] Two-sigma counting error provided when available.
[c] Not analyzed because sample was sour.
NA, not analyzed.
NS, no sample.

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(*1*) SHARPE, T. J. and J. L. STEIN. Standby Milk Surveillance Network. Radiol Health Data 8:379–382 (August 1970).

(*2*) JOHNS, F. B. Southwestern radiological health handbook of radiochemical analytical methods, SWRHL–11. Southwestern Radiological Health Laboratory, Las Vegas, Nev. (March 1970).

(*3*) LEM, P. N. and R. N. SNELLING. Southwestern Radiological Health Laboratory data analysis and procedures manual, SWRHL–21. Southwestern Radiological Health, Laboratory, Las Vegas, Nev. (March 1971).

Food and Diet Surveillance

Efforts are being made by various Federal and State agencies to estimate the dietary intake of selected radionuclides on a continuing basis. These estimates, along with the guidance developed by the Federal Radiation Council, provide a basis for evaluating the significance of radioactivity in foods and diet.

Networks presently in operation and reported routinely include those listed below. These networks provide data useful for developing estimates of nationwide dietary intake of radionuclides. Programs reported in *Radiation Data and Reports* are as follows:

Program	Period reported	Issue
California Diet Study	January–June 1971	December 1972
Carbon-14 in Total Diet and Milk	July–December 1971	May 1972
Radiostrontium in Milk	January–December 1971	November 1972
Strontium-90 in Tri-City Diets	January–December 1971	December 1972

Radionuclides in Institutional Diet Samples, April-June 1972

Environmental Protection Agency and Food and Drug Administration

The determination of radionuclide concentrations in the diet constitutes an important element of an integrated program of environmental radiological surveillance and assessment. Recognizing that the diet is a potentially significant contribution to total environmental radiation exposures, the Public Health Service initiated its Institutional Diet Sampling Program in 1961. The program is now administered by the Office of Radiation Programs, Environmental Protection Agency with the assistance of the Office of Food Sanitation, Food and Drug Administration, Department of Health, Education, and Welfare (*1*).

This program estimates the dietary intake of radionuclides in a selected population group, ranging from children to young adults of school age. At present, 26 institutions—distributed geographically as shown in figure 1—are being sampled. Previous results showed that the daily dietary intake of teenage girls and children from 9 to 12 years of age were comparable, but teenage boys consumed 20 percent more food per day (*1*, *2*). Extrapolating this information, estimates for teenage boys and/or girls can be calculated on the basis of the dietary intake of children.

The sampling procedure is generally the same at each institution. Each sample represents the edible portion of the diet for a full 7-day week (21 meals plus between-meal snacks), obtained by duplicating the food intake of a different individual daily. Drinking water—which is not included—is also sampled periodically. Each daily sample is kept frozen until the end of the collection period. It is then packed in dry ice and shipped by air to either the National Environmental Research Center, Las Vegas, Nev., or the Eastern Environmental Radiation Facility, Montgomery, Ala. A detailed description of sampling and analytical procedures has already been presented in *Radiological Health Data and Reports* (*3*).

Results

Table 1 shows the analytical results for institutional diet samples collected from all stations during April–June 1972. The stable elements, calcium and potassium are reported in

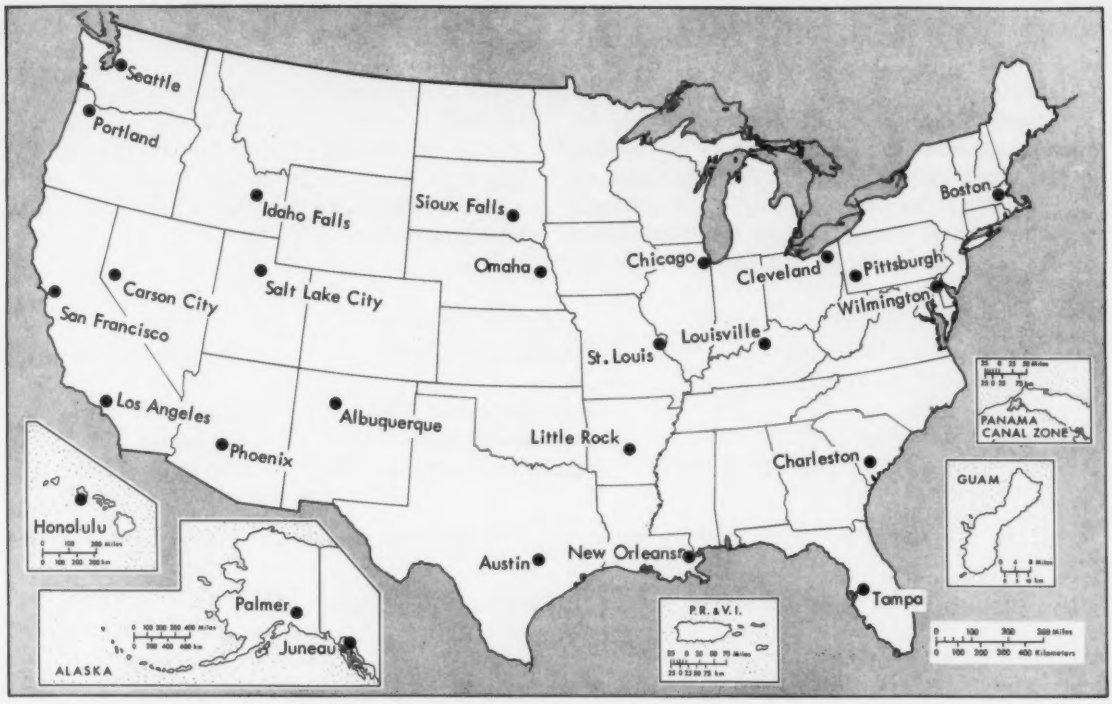

Figure 1. Institutional diet sampling locations as of June 1972

Table 1. Concentration and intake of stable elements and radionuclides in institutional total diets of children April-June 1972

Location of Institution	Month (1972)	Total weight (kg/day)	Calcium		Potassium		Strontium-90		Cesium-137	
			(g/kg)	(g/day)	(g/kg)	(g/day)	(pCi/kg)	(pCi/day)	(pCi/kg)	(pCi/day)
Alaska: Juneau	April[a]	2.97	0.7	2.0	1.4	4.0	3	10	14	42
Palmer		NS								
Ariz: Phoenix	April	1.52	.5	.7	2.2	3.3	4	5	0	0
Ark: Little Rock	April	1.48	.7	1.0	1.7	2.5	7	11	0	0
Calif: Los Angeles		NS								
San Francisco	April[a]	2.06	.6	1.2	1.5	3.0	3	6	0	0
Del: Wilmington	April[a]	.84	.6	.5	1.5	1.3	5	4	12	10
Fla: Tampa	April	3.31	.5	1.8	1.4	4.7	4	14	15	50
Hawaii: Honolulu	April	2.34	.4	1.1	1.7	3.9	4	8	0	0
Idaho: Idaho Falls	April[a]	1.06	.4	.4	1.5	1.6	4	4	0	0
Ill: Chicago	April[a]	1.92	.7	1.3	1.5	2.8	6	11	14	27
Ky: Louisville	April	1.88	.7	1.2	1.5	2.7	6	11	12	23
La: New Orleans	April[a]	1.58	.6	.9	1.6	2.6	7	11	12	19
Mass: Boston	April	2.47	.5	1.3	1.3	3.1	4	10	0	0
Mo: St. Louis	April[a]	1.09	.8	.9	1.9	2.1	4	5	18	20
Nebr: Omaha	April[a]	1.80	.7	1.2	1.5	2.7	0	0	0	0
Nev: Carson City	April	1.36	.9	1.2	1.6	2.2	4	6	0	0
N. Mex: Albuquerque		NS								
Ohio: Cleveland	April[a]	1.49	.7	1.0	1.7	2.5	4	6	12	18
Oreg: Portland	April[a]	2.19	.6	1.2	1.8	3.9	3	7	17	37
Pa: Pittsburgh	April	2.39	.5	1.2	1.3	3.1	4	11	0	0
S.C: Charleston	April	2.22	.6	1.3	1.5	3.2	5	11	15	33
S. Dak: Sioux Falls	April[a]	1.20	.7	.8	1.4	1.6	5	6	0	0
Tex: Austin	April[a]	1.09	.8	.8	2.5	2.8	6	6	0	0
Utah: Salt Lake City	April[a]	2.76	.6	1.7	1.4	3.8	3	8	13	36
Wash: Seattle	April[a]	1.80	.5	.9	1.8	3.2	3	5	11	20
Institutional average		1.86	0.6	1.1	1.6	2.9	4	8	7	14

[a]Food samples were collected from two or more children who were not between the ages of 9 and 12.

Note: Iodine-131 and barium-140 were not detected at any station during this period. Omaha, Nebr. had a strontium-89 concentration of 7 pCi/kg or 13 pCi/day.

NS, no sample.

g/kg of diet. When applicable, radionuclide concentrations of these samples reported in pCi/kg of diet are corrected for radioactive decay to the midpoint of the sample collection period. Dietary intakes in g/day or pCi/day were obtained by multiplying the food consumption rate in kg/day by the appropriate concentration values. The average food consumption rate during this period was 1.86 kg/day compared to the network average of 1.85 kg/day observed from 1961 through 1971.

Strontium-90 dietary intake averaged 8 pCi/day during this period. Cesium-137 intake averaged 14 pCi/day. These results fall within Range I as defined by the former Federal Radiation Council (*4*). Barium-140 and iodine-131 concentrations were below detectable levels. Strontium-89 was detected in Omaha, Nebr.

All concentrations less than or equal to the appropriate minimum detectable level have been reported as zero. The minimum detectable concentration is defined as the measured concentration equal to the 2-standard-deviation analytical error. Accordingly, the minimum detectable limits are strontium-89, 5 pCi/kg; strontium-90, 2 pCi/kg; iodine-131, 10 pCi/kg; barium-140, 10 pCi/kg; and cesium-137, 10 pCi/kg.

Recent coverage in *Radiation Data and Reports:*

Period	Issue
April–June 1971	November 1971
July–September 1971	April 1972
October–December 1971	June 1972
January–March 1972	June 1973

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(*2*) PUBLIC HEALTH SERVICE, DIVISION OF RADIOLOGICAL HEALTH. Radionuclides in institutional total diet samples, January–March 1965. Radiol Health Data 6:548–554 (October 1965).

(*3*) PUBLIC HEALTH SERVICE, NATIONAL CENTER FOR RADIOLOGICAL HEALTH. Radionuclides in institutional total diet samples, January–March 1968. Radiol Health Data Rep 9:557–560 (October 1968).

(*4*) FEDERAL RADIATION COUNCIL. Background material for the development of radiation protection standards, Report No. 2. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (September 1961).

SECTION II. WATER

The Environmental Protection Agency and other Federal, State, and local agencies operate extensive water quality sampling and analysis programs for surface, ground, and treated water. Most of these programs include determinations of gross beta and gross alpha radioactivity and specific radionuclides.

Although the determination of the total radionuclide intake from all sources is of primary importance, a measure of the public health importance of radioactivity levels in water can be obtained by comparison of the observed values with the Public Health Service Drinking Water Standards (*1*). These standards, based on consideration of Federal Radiation Council (FRC) recommendations (*2–4*) set the limits for approval of a drinking water supply containing radium-226 and strontium-90 at 3 pCi/liter and 10 pCi/liter, respectively. Higher concentrations may be acceptable if the total intake of radioactivity from all sources remains within the guides recommended by FRC for control action. In the known absence[1] of strontium-90 and alpha-particle emitters, the limit is 1,000 pCi/liter gross beta radioactivity, except when additional analysis indicates that concentrations of radionuclides are not likely to cause exposures greater than the limits indicated by the Radiation Protection Guides. Surveillance data from a number of Federal and State programs are published periodically to show current and long-range trends. Water sampling activities reported in *Radiation Data and Reports* are listed below.

[1] Absence is taken to mean a negligibly small fraction of the specific limits of 3 pCi/liter and 10 pCi/liter for unidentified alpha-particle emitters and strontium-90, respectively.

Water sampling program	Period reported	Issue
California	January–December 1970	June 1972
Colorado River Basin	1968	March 1972
Community Water Supply Study	1969	September 1972
Florida	1969	January 1972
Interstate Carrier Drinking Water	1971	May 1972
Kansas	January–December 1971	February 1973
Minnesota	July 1970–June 1971	November 1972
New York	July–December 1970 and January–June 1971	May 1972
North Carolina	1968–1970	September 1972
Radiostrontium in Tap Water, *HASL*	July–December 1971	November 1972
Washington	July 1969–June 1970	March 1972
Water Surveillance Programs, *NERC-LV*	December 1972	June 1973

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Gross Radioactivity in Surface Waters of the United States January 1969-December 1970

Office of Water Planning and Standards
U.S. Environmental Protection Agency

The monitoring of gross radioactivity in surface waters of the United States was initiated in 1957 as part of the Water Pollution Surveillance System (formerly National Water Quality Network) of the U.S. Public Health Service. Currently, the program is operated by the U.S. Environmental Protection Agency, Office of Water Planning and Standards. Regional offices of the Environmental Protection Agency are responsible for the collection and retrieval system. Radioactivity analyses were performed in the centralized laboratories of the Office of Water Planning and Standards (Cincinnati, Ohio).

Table 1 presents the gross alpha and beta radioactivity results for samples collected during January 1969–December 1970. The analytical procedures used for determining gross alpha and beta radioactivity are described in the 13th Edition of *Standard Methods for the Examination of Water and Wastewater* (*1*). Results are presented for the date of counting and are not corrected to the date of collection. The sensitivity in counting is that defined by the National Bureau of Standards, Handbook 86 (*2*) and is calculated to be <0.2 pCi/liter for gross alpha radioactivity and <1 pCi/liter for gross beta radioactivity measurements.

REFERENCES

(*1*) AMERICAN PUBLIC HEALTH ASSOCIATION: AMERICAN WATER WORKS ASSOCIATION AND WATER POLLUTION CONTROL FEDERATION. Standard methods for the examination of water and wastewater, 13th Edition, New York, N.Y. (1971).

(*2*) U.S. DEPARTMENT OF COMMERCE. Radioactivity, Recommendations of the International Commission on Radiological Units and Measurements (1962), NBS Handbook 86 (November 29, 1963).

Table 1. Gross radioactivity in U.S. surface waters, January 1969-December 1970

River and station	Sampling frequency [a]	Date	Gross alpha radioactivity (pCi/liter)		Gross beta radioactivity (pCi/liter)	
			Suspended solids	Dissolved solids	Suspended solids	Dissolved solids
		1969				
Ohio River:						
Evansville, Ind	4	1/2	0.8	<1.0	<1	<2
Cuyahoga River:						
Cleveland, Ohio	4	3/26	.4	1.7	0	<3
Lake Erie:						
Buffalo, N.Y	4	3/26	<.2	<1.1	0	<2
Maumee River:						
Toledo, Ohio	4	3/26	.8	2.2	10	25
Ohio River:						
Cane Run, Ky	4	3/25	1.1	<.6	6	5
Louisville, Ky	4	3/25	1.4	.3	5	5
Clinch River:						
Kingston, Tenn	[b]	5/5	<.2	.7	0	30
		5/12	<.2	<.5	0	28
		5/19	<.2	<.4	1	8
		5/26	<.2	3.0	2	42
Mississippi River:						
Cape Girardeau, Mo	4	5/26	1.4	.9	25	25
Allegheny River:						
Pittsburgh, Pa	4	6/16	<.2	<1.7	6	8
	4	6/30	.3	<.9	0	4
Arkansas River:						
Fort Smith, Ark	4	6/25	2.0	.4	11	8
Little Rock, Ark	4	6/25	2.4	<1.5	8	7
Pendleton Ferry, Ark	4	6/25	1.5	<1.2	6	9
Ponca City, Okla	4	6/30	5.2	.5	38	9
Atchafalaya River:						
Morgan City, La	[b]	6/3	2.2	.6	8	7
Big Sioux River:						
Sioux Falls, S. Dak	[b]	6/18	.9	21.1	7	52
		6/25	.8	.9	8	22
Chattahoochee River:						
Columbus, Ga	4	6/30	.7	<.2	2	2
Lanett, Ala	4	6/30	.9	<.3	4	2
Clinch River:						
Kingston, Tenn	[b]	6/2	<.2	.5	1	8
		6/9	<.2	.2	4	4
		6/23	<.2	1.6	0	11
		6/30	<.2	1.0	0	11
Coosa River:						
Rome, Ga	4	6/25	<.3	<.3	1	10
Cuyahoga River:						
Cleveland, Ohio	4	6/25	.2	7.4	5	13
Delaware River:						
Mastens Creek, Pa	[b]	6/19	.9	<.3	9	5
Philadelphia, Pa	[b]	6/18	.4	<.4	2	4
Trenton, N.J	[b]	6/16	2.1	.3	11	3
Escambia River:						
Century, Fla	4	6/25	.4	<.5	3	7
Great Miami:						
American Materials Bridge, Ohio	[b]	6/18	<.3	1.9	4	7
Lost Brid e, Ohio	[b]	6/18	1.5	.9	11	24
Sellars Road, Ohio	[b]	6/18	.6	1.9	4	7
Green River:						
Spotsville, Ky	[b]	6/25	1.7	<.8	7	3
Hudson River:						
Poughkeepsie, N.Y	[b]	6/19	<.2	<.4	1	4
Kanawha River:						
Mason County, W. Va	4	6/24	.3	<.3	1	1
Winfield Dam, W. Va	4	6/30	<.3	<.7	0	2
Kansas River:						
Holliday, Kans	[b]	6/16	10.5	1.6	63	18
		6/23	7.9	.9	48	13
		6/30	11.3	1.5	65	13
Lake Erie:						
Buffalo, N.Y	4	6/25	<.2	3.4	0	3
Licking River:						
Covington, Ky	[b]	6/19	.4	<.7	4	7
Little Miami River:						
Cincinnati, Ohio	[b]	6/18	.8	<1.2	8	6
Maumee River:						
Toledo, Ohio	4	6/25	<.4	.3	7	8
Merrimac River:						
Lowell, Mass	[b]	6/24	<.2	<.4	3	7
Mississippi River:						
Vicksburg, Miss	4	6/23	2.5	.2	12	6
	[b]	6/24	<.9	<.3	14	6
West Memphis, Ark	4	6/23	3.5	.6	10	7
Missouri River:						
Bismarck, N. Dak	4	6/17	<.2	<.8	0	2
	[b]	6/17	<.3	2.7	1	10
	[b]	6/24	<.2	3.5	1	14
St. Joseph, Mo	4	6/17	3.5	1.9	20	20

See footnotes at end of table.

Table 1. Gross radioactivity in U.S. surface waters, January 1969-December 1970—continued

River and station	Sampling frequency [a]	Date	Gross alpha radioactivity (pCi/liter)		Gross beta radioactivity (pCi/liter)	
			Suspended solids	Dissolved solids	Suspended solids	Dissolved solids
		1969				
Monongahela River:						
Pittsburgh, Pa.	4	6/20	<.2	.9	0	4
	4	6/16	.8	.4	2	<1
North Platte River:						
Henry, Nebr.	(b)	6/16	.6	43.0	7	68
	(b)	6/23	<.2	19.4	3	51
	(b)	6/30	.5	17.5	4	29
Ohio River:						
Addison, Ohio	4	6/20	1.0	<.8	2	6
Anderson Ferry, Ohio	(b)	6/19	.3	<.9	2	5
Boyd County, Ky.	4	6/10	<.3	<.8	0	4
Cane Run, Ky.	(b)	6/24	<.3	<.8	3	6
Cincinnatti, Ohio	(b)	6/18	<.2	<.9	0	8
	(b)	6/18	.2	<1.3	1	11
East Liverpool, Ohio	4	6/17	<.3	<1.0	0	3
Evansville, Ind.	4	6/25	1.1	<.9	9	6
Gallipolis, Ohio	4	6/25	<.2	<.7	0	2
Greenup Dam, Ky.	(b)	6/18	.2	<1.1	1	5
Ironton, Ohio	(b)	6/18	<.3	<.9	1	4
	(b)	6/18	23.3	.3	0	1
Kyger Creek, W. Va.	4	6/25	.3	.3	1	4
Louisville, Ky.	(b)	6/24	1.5	<.8	7	6
Madison, Idaho	(b)	6/19	.2	<.9	2	7
Marietta, Ohio	4	6/20	<.2	<.8	0	3
Markland, Dam, Ky.	(b)	6/19	<.2	<1.5	1	16
Maysville, Ky.	(b)	6/18	.7	<1.1	5	25
Meldahl Dam, Ohio	(b)	6/19	<.2	<.8	1	5
Miami Fort, Ohio	(b)	6/18	1.8	.3	3	5
New Martinsville, Ohio	4	6/16	<.2	<.8	0	4
Old Lock #19, W. Va.	4	6/24	<.3	<.9	0	4
Portsmouth, Ohio	(b)	6/18	.4	<.7	1	4
	(b)	6/18	.5	<.8	2	4
Warwood, W. Va.	4	6/18	<.2	<.8	0	3
Platte River:						
Plattsmouth, Nebr.	(b)	6/17	4.9	2.4	26	15
Red River:						
Dennison, Tex.	4	6/30	<.2	<2.8	0	12
Index, Ark.	(b)	6/10	2.2	.8	9	53
Rio Grande:						
Brownsville, Tex.	4	6/30	.2	1.7	0	13
El Paso, Tex.	4	6/11	1.7	2.7	7	20
Laredo, Tex.	4	6/30	.6	1.0	8	11
Sabine River:						
Ruliff, Tex.	(b)	6/17	1.2	.3	4	7
Schuylkill River:						
Philadelphia, Pa.	(b)	6/16	.4	<1.0	3	7
Scioto River:						
Lucasville, Ohio	(b)	6/18	2.6	1.1	18	10
South Platte River:						
Julesburg, Colo.	(b)	6/11	6.6	43.2	39	60
	(b)	6/25	7.0	16.2	30	48
	(b)	6/30	4.8	49.0	16	75
Tennessee River:						
Bridgeport, Ala.	4	6/25	<.2	<.4	0	10
Kentucky Dam, Ky.	(b)	6/19	.2	<.8	2	4
	(b)	6/19	.5	<.9	2	12
Tombigbee River:						
Columbus, Miss.	4	6/23	.5	<.3	4	11
Verdigris River:						
Norwata, Okla.	4	6/30	2.0	1.7	19	7
Big Horn River:						
Hardin, Mont.	(b)	7/7	8.8	3.7	49	12
Big Sioux River:						
Sioux Falls, S. Dak.	(b)	7/9	1.2	6.5	11	51
Clinch River:						
Kingston, Tenn.	(b)	7/7	1.2	.3	14	19
	(b)	7/28	<.3	<.3	0	4
Delaware River:						
Philadelphia, Pa.	(b)	7/1	<.2	<.3	1	4
Great Miami River:						
American Materials Bridge, Ohio	(b)	7/16	1.3	1.2	6	5
Liberty Fairfield, Ohio	(b)	7/16	1.0	.5	5	5
Sellars Road, Ohio	(b)	7/16	<.3	3.8	3	4
Kansas River:						
Holliday, Kans.	(b)	7/14	12.0	1.6	51	13
	(b)	7/21	<3.3	6.2	53	11
Lake Superior:						
Duluth, Minn.	(b)	7/28	<.2	<.3	0	1
Licking River:						
Covington, Ky.	(b)	7/17	<.3	1.0	4	5
Missouri River:						
Bismarck, N. Dak.	(b)	7/29	.3	1.3	2	12
	(b)	7/22	1.2	3.2	9	11

See footnotes at end of table.

Table 1. Gross radioactivity in U.S. surface waters, January 1969-December 1970—continued

River and station	Sampling frequency [a]	Date	Gross alpha radioactivity (pCi/liter)		Gross beta radioactivity (pCi/liter)	
			Suspended solids	Dissolved solids	Suspended solids	Dissolved solids
		1969				
Missouri River:						
Bismarck, N. Dak	(b)	7/15	1.0	1.9	6	12
	(b)	7/8	1.1	3.0	7	13
	(b)	7/1	<.2	2.7	1	11
St. Joseph, Mo	(b)	7/29	2.5	.7	19	13
Yankton, S. Dak	(b)	7/7	6.1	1.8	25	18
North Platte River:						
Henry, Nebr	(b)	7/21	2.4	8.9	8	29
	(b)	7/28	3.8	8.9	13	22
North Red River:						
Grand Forks, N. Dak	(b)	7/9	1.6	3.8	8	48
Ohio River:						
Anderson Ferry, Ohio	(b)	7/17	<.3	2.7	4	6
Cincinnati, Ohio	(b)	7/2	<.2	<1.0	2	4
	(b)	7/16	.9	<.7	3	4
	(b)	7/17	<.3	1.7	3	6
	(b)	7/23	4.2	<.7	15	17
	(b)	7/30	.2	<1.1	4	7
Eldean, Ohio	(b)	7/7	3.4	8.2	19	25
Greenup Dam, Ky	(b)	7/17	<.4	1.1	5	6
Ironton, Ohio	(b)	7/17	1.4	<.7	6	4
Markland Dam, Ky	(b)	7/17	.2	<1.0	0	5
Maysville, Ky	(b)	7/17	<.4	.2	6	4
Meldahl Dam, Ohio	(b)	7/17	.7	<.8	3	7
Miami Fort, Ohio	(b)	7/16	.8	<1.3	3	7
Portsmouth, Ohio	(b)	7/17	.2	<.7	3	10
Platte River:						
Plattsmouth, Nebr	(b)	7/8	10.2	5.9	28	28
	(b)	7/1	7.5	2.9	42	18
Schuylkill River:						
Philadelphia, Pa	(b)	7/1	.2	<.9	1	6
Scioto River:						
Lucasville, Ohio	(b)	7/17	2.3	5.1	12	20
Susquehanna River:						
Holtwood, Pa	(b)	7/9	.2	.2	1	5
Tennessee River:						
Kentucky Dam, Ky	(b)	7/17	<.2	2.0	1	4
Clinch River:						
Kingston, Tenn	(b)	8/11	.2	.2	0	9
	(b)	8/17	<.2	<.4	0	6
	(b)	8/25	<.2	.2	0	10
Great Miami River:						
Liberty Fairfield, Ohio	(b)	8/20	<.3	.5	2	16
Lost Bridge, Ohio	(b)	8/20	.5	1.6	3	19
Sellars Road, Ohio	(b)	8/20	<.2	<2.0	1	7
Lake Superior:						
Duluth, Minn	(b)	8/25	<.2	<.3	0	2
Licking River:						
Covington, Ky	(b)	8/21	3.3	<.5	11	8
Little Miami River:						
Cincinnati, Ohio	(b)	8/19	.4	.9	4	7
Missouri River:						
Bismarck, N. Dak	(b)	8/5	.3	1.1	6	13
	(b)	8/12	.2	2.9	1	12
	(b)	8/19	<.3	.7	1	17
	(b)	8/26	.6	3.4	5	11
North Platte River:						
Henry, Nebr	(b)	8/4	<1.6	<6.8	8	23
	(b)	8/11	.8	8.1	4	27
	(b)	8/25	.8	8.2	6	21
Ohio River:						
Anderson Ferry, Ohio	(b)	8/21	.3	<.9	1	6
Cincinnati, Ohio	(b)	8/8	<1.0	<4.3	1	3
	(b)	8/13	.4	<.7	1	8
	(b)	8/19	<.2	<1.1	0	5
	(b)	8/27	<.2	<.8	0	8
Greenup Dam, Ky	(b)	8/19	.2	<.9	2	10
Ironton, Ohio	(b)	8/19	.3	<.8	1	6
Louisville Ky	(b)	8/4	<.2	<.9	1	5
Madison, Ind	(b)	8/21	.5	<.8	3	10
Markland Dam, Ky	(b)	8/21	<.3	<.8	2	5
Maysville, Ky	(b)	8/19	1.1	<.9	4	9
Meldahl Dam, Ohio	(b)	8/19	<.2	<1.0	2	16
Miami Fort, Ohio	(b)	8/19	<.3	<1.1	2	8
Portsmouth, Ohio	(b)	8/19	1.1	<.9	4	9
Scioto River:						
Lucasville, Ohio	(b)	8/19	.7	1.6	3	7
South Platte River:						
Julesburg, Colo	(b)	8/25	.6	21.1	9	43
Tennessee River:						
Kentucky Dam, Ky	(b)	8/21	.9	<.8	6	5
Whitewater River:						
Elizabethtown, Ohio	(b)	8/20	<.3	<1.8	1	5
Allegheny River:						
Pittsburgh, Pa	4	9/18	.2	<.7	0	4
	4	9/18	<.2	<.8	1	4

See footnotes at end of table.

Table 1. Gross radioactivity in U.S. surface waters, January 1969-December 1970—continued

River and station	Sampling frequency [a]	Date	Gross alpha radioactivity (pCi /liter)		Gross beta radioactivity (pCi /liter)	
			Suspended solids	Dissolved solids	Suspended solids	Dissolved solids
		1969				
Arkansas River:						
Coolidge, Kans	4	9/2	9.1	15.8	12	33
Fort Smith, Ark	4	9/17	1.7	1.5	5	4
Little Rock, Ark	4	9/24	.8	.8	4	11
Pendleton Ferry, Ark	4	9/24	.6	1.4	3	6
Ponca City, Okla	4	9/29	10.4	5.4	16	17
Chattahoochee River:						
Columbus, Ga	4	9/29	.3	<1.5	1	13
Lanett, Ala	4	9/29	1.3	.5	8	7
Clinch River:						
Kingston, Tenn	[b]	9/15	<.3	<.7	2	<1
	[b]	9/22	<.3	<.9	0	7
	[b]	9/29	<.3	.5	0	3
Coosa River:						
Rome, Ga	4	9/25	.2	1.2	4	7
Cuyahoga River:						
Cleveland, Ohio	[b]	9/31	1.6	2.5	4	10
Escambia River:						
Century, Fla	4	9/23	.5	1.3	2	19
Great Miami River:						
American Materials Bridge, Ohio	[b]	9/24	1.4	<3.0	9	8
Liberty Fairfield, Ohio	[b]	9/24	<.3	.9	2	10
Green River:						
Spottsville, Ky	4	9/15	.8	<.5	5	3
Illinois River:						
Peoria, Ill	3	9/10	2.0	.4	8	7
Kanawha River:						
Winfield Dam, W. Va	4	9/18	<.2	.4	1	4
Lake Erie:						
Buffalo, N.Y	4	9/17	1.1	.2	5	6
	4	9/24	<.2	.5	0	2
Lake Michigan:						
Milwaukee, Wis	4	9/8	<.2	.5	0	3
Lake Superior:						
Duluth, Minn	[b]	9/29	<.2	<.2	0	3
Licking River:						
Covington, Ky	[b]	9/25	<.3	<1.4	1	6
Little Miami River:						
Cincinnati, Ohio	[b]	9/24	1.2	<1.7	6	5
Maumee River:						
Toledo, Ohio	4	9/24	.5	.8	3	3
Mississippi River:						
Lock and Dam, Minn	[b]	9/17	.3	.9	2	10
Cape Girardeau, Mo	3	9/2	4.4	<1.5	23	4
Dubuque, Iowa	3	9/2	.4	1.3	3	8
West Memphis, Ark	4	9/29	3.0	1.6	3	9
Vicksburg, Miss	4	9/22	1.0	.3	2	2
	4	9/25	4.6	1.1	4	5
Missouri River:						
Bismarck, N. Dak	[b]	9/26	<.3	2.9	2	12
St. Joseph, Mo	[b]	9/23	2.2	2.0	9	15
Monongahela River:						
Pittsburgh, Pa	4	9/18	.2	.2	1	6
	4	9/18	<.2	1.4	0	9
North Platte River:						
Henry, Nebr	[b]	9/8	.5	13.0	5	27
North Red River:						
Grand Forks, N. Dak	[b]	9/3	.3	3.8	3	20
Ohio River:						
Anderson Ferry, Ohio	[b]	9/25	<.3	<1.0	1	6
Boyd County, Ky	4	9/17	1.5	.2	6	5
Cane Run, Ky	[b]	9/17	<.3	.5	2	5
Cincinnati, Ohio	[b]	9/4	<.3	<.8	1	3
	[b]	9/24	<.2	<1.6	1	6
	[b]	9/17	<.3	<1.0	1	5
	[b]	9/24	.4	<1.2	2	5
East Liverpool, Ohio	4	9/15	<.2	.3	0	7
Eldean, Ohio	[b]	9/24	<.3	<1.8	3	9
Gallipolis, Ohio	4	9/17	<.3	<1.4	2	7
Greenup Dam, Ky	[b]	9/24	.9	<2.1	3	6
Ironton, Ohio	[b]	9/24	<.3	.3	3	5
Kyger Creek, W. Va	4	9/17	.5	.6	2	5
Louisville, Ky	4	9/17	<.3	.5	1	10
Marietta, Ohio	4	9/18	.5	<1.1	2	9
Markland Dam, Ky	[b]	9/25	.5	<1.1	1	8
Meldahl Dam, Ohio	[b]	9/30	<.3	<.6	1	4
New Martinsville, Ohio	4	9/16	.4	<.9	1	6
Old Lock #19, W. Va	4	9/18	.6	1.3	1	6
Portsmouth, Ohio	[b]	9/24	.2	.4	1	5
South Heights, Pa	4	9/18	.2	.7	1	5
Warwood, W. Va	4	9/15	.3	<.9	0	7
Red River:						
Dennison, Tex	4	9/29	.2	.3	1	14
Index, Ark	4	9/24	.2	1.5	1	8

See footnotes at end of table.

Table 1. Gross radioactivity in U.S. surface waters, January 1969-December 1970—continued

River and station	Sampling frequency [a]	Date	Gross alpha radioactivity (pCi/liter)		Gross beta radioactivity (pCi/liter)	
			Suspended solids	Dissolved solids	Suspended solids	Dissolved solids
		1969				
Rio Grande:						
Brownsville, Tex	4	9/29	0.5	1.4	3	17
El Paso, Tex	4	9/8	3.7	.4	6	8
Laredo, Tex	4	9/29	.7	3.8	2	4
Sabine River:						
Ruliff, Tex	4	9/23	.2	<.2	1	6
St. Lawrence River:						
Massena, N.Y	1	9/29	<.2	<.6	0	6
South Platte River:						
Julesburg, Colo	(b)	9/8	<.2	21.3	3	48
Tennessee River:						
Bridgeport, Ala	4	9/17	<.3	<1.5	3	17
Kentucky Dam, Ky	(b)	9/25	.3	<.9	1	7
Trinity River:						
Livingston, Tex	4	9/25	<.2	.9	1	11
Tombigbee River:						
Columbus, Miss	4	9/22	.3	.2	2	5
Verdigris River:						
Norwata, Okla	4	9/29	1.0	1.1	2	3
Whitewater River:						
Elizabethtown, Ohio	(b)	9/24	<.3	<2.0	1	4
Arkansas River:						
Fort Smith, Ark	3	10/22	2.7	.2	3	0
Little Rock, Ark	3	10/29	1.6	6.6	2	2
Pendleton Ferry, Ark	3	10/29	2.2	5.0	2	11
Clinch River:						
Kingston, Tenn	(b)	10/13	<.2	1.0	1	8
	(b)	10/20	<.3	<.7	0	8
Delaware River:						
Philadelphia, Pa	3	10/2	.3	<.3	1	4
Great Miami River:						
American Materials Bridge, Ohio	(b)	10/22	.3	.7	1	11
Liberty Fairfield, Ohio	(b)	10/22	<.2	.4	0	6
Sellers Road, Ohio	(b)	10/22	.3	.8	2	6
Lake Superior:						
Duluth, Minn	(b)	10/27	<.2	<.4	2	4
Licking River:						
Covington, Ky	(b)	10/22	<.2	<.7	1	7
Little Miami River:						
Cincinnati, Ohio	(b)	10/22	.2	1.3	3	6
Missouri River:						
St. Joseph, Mo	(b)	10/21	3.1	1.8	3	28
North Red River:						
Grand Forks, N. Dak	(b)	10/8	.4	1.3	2	22
Ohio River:						
Cincinnati, Ohio	(b)	10/1	.3	.5	0	5
	(b)	10/8	<.2	.5	0	1
	(b)	10/15	.2	.2	0	2
	(b)	10/22	.2	.7	0	1
	(b)	10/22	.2	.2	1	4
	(b)	10/29	.4	<.5	0	0
Eldean, Ohio	(b)	10/22	<.2	2.8	2	12
Greenup Dam, Ky	(b)	10/22	.4	<2.1	2	5
Ironton, Ohio	(b)	10/22	.5	<1.7	1	6
Markland Dam, Ky	(b)	10/22	.4	.7	2	3
Maysville, Ky	(b)	10/22	1.1	.2	4	5
Meldahl Dam, Ohio	(b)	10/22	.4	.2	1	6
Miami Fort, Ohio	(b)	10/22	.3	.3	1	6
Portsmouth, Ohio	(b)	10/22	.2	.4	1	7
Platte River:						
Plattsmouth, Nebr	4	10/21	<.3	12.0	2	27
St. Lawrence River:						
Massena, N.Y	(b)	10/13	<.3	<.8	0	3
	(b)	10/20	<.3	.7	0	3
	(b)	10/22	.2	.2	1	9
	(b)	10/27	<.3	.5	0	1
St. Mary River:						
Saulte St. Marie, Mich	(b)	10/6	<.2	6.8	0	2
Schuylkill River:						
Philadelphia, Pa	3	10/3	<.2	.2	0	7
Tennessee River:						
Kentucky Dam, Ky	(b)	10/22	.7	.9	0	6
Whitewater River:						
Elizabethtown, Ohio	(b)	10/22	<.2	.4	2	9
Clinch River:						
Kingston, Tenn	(b)	11/10	<.3	<.7	2	2
	(b)	11/23	<.3	<.5	1	0
	(b)	11/17	.3	.2	0	1
Great Miami River:						
American Materials Bridge, Ohio	(b)	11/25	.8	<1.5	2	3
Liberty Fairfield, Ohio	(b)	11/25	.9	<2.4	4	2
Lost Bridge, Ohio	(b)	11/25	1.5	<2.1	2	2
Sellars Road, Ohio	(b)	11/25	<.3	<2.3	0	2

See footnotes at end of table.

Table 1. Gross radioactivity in U.S. surface waters, January 1969-December 1970—continued

River and station	Sampling frequency [a]	Date	Gross alpha radioactivity (pCi/liter)		Gross beta radioactivity (pCi/liter)	
			Suspended solids	Dissolved solids	Suspended solids	Dissolved solids
		1969				
Licking River:						
Covington, Ky	(b)	11/24	1.1	<1.7	4	<3
Little Miami:						
Cincinnati, Ohio	(b)	11/24	.7	1.0	4	4
Missouri River:						
Bismarck, N. Dak	(b)	11/30	.9	.8	1	0
North Red River:						
Grand Forks, N. Dak	(b)	11/5	<.2	1.2	0	10
Ohio River:						
Cairo, Ill	(b)	11/24	1.0	<1.1	1	1
Cincinnati, Ohio	(b)	11/5	<.2	.4	1	<3
	(b)	11/12	<.3	.4	0	18
	(b)	11/24	.3	<1.9	1	10
	(b)	11/26	.5	.3	4	8
	(b)	11/19	.4	<.7	2	9
Eldean, Ohio	(b)	11/25	.7	<1.5	3	5
Greenup Dam, Ky	(b)	11/24	.6	.4	1	4
Ironton, Ohio	(b)	11/24	.6	.3	3	7
Madison, Ind	(b)	11/25	.4	<2.3	1	2
Markland Dam, Ky	(b)	11/24	.7	.3	4	8
		11/25	.4	<1.9	0	<3
Maysville, Ky	(b)	11/24	.4	.6	3	7
Miami Fort, Ohio	(b)	11/25	.8	<4.4	2	12
Portsmouth, Ohio	(b)	11/24	.7	1.0	3	3
Potomac River:						
Williamsport, Md	(b)	11/30	.2	.6	1	1
St. Lawrence River:						
Massena, N. Y	(b)	11/3	<.2	<.8	0	12
	(b)	11/10	.3	.7	4	9
	(b)	11/17	.2	.5	2	11
	(b)	11/24	<.3	<1.2	3	16
Tennessee River:						
Kentucky Dam, Ky	(b)	11/25	.7	<.9	1	1
Whitewater River:						
Elizabethtown, Ohio	(b)	11/25	.6	1.1	2	2
Allegheny River:						
Pittsburgh, Pa	4	12/31	<.2	.2	3	16
	4	12/31	.2	.4	0	<2
Arkansas River:						
Ponca City, Okla	4	12/29	2.9	4.2	4	2
Big Sandy River:						
Big Sandy, W. Va	4	12/31	<.2	1.0	17	46
Big Sioux River:						
Sioux Falls, S. Dak	(b)	12/12	.4	1.4	0	<5
Chattahoochee River:						
Columbus, Ga	4	12/29	<.2	.2	2	0
Lanett, Ala	4	12/2	.6	.2	0	0
Clinch River:						
Kingston, Tenn	(c)	12/8	.2	.2	0	0
	(c)	12/1	<.3	<.4	0	0
	(c)	12/15	<.3	.2	0	0
	(c)	12/22	.2	<.4	6	14
	(c)	12/29	.5	.8	8	7
Coosa River:						
Rome, Ga	4	12/17	.3	.2	0	0
Cuyahoga River:						
Cleveland, Ohio	4	12/31	.6	2.3	20	29
Delaware River:						
Mastens Creek, Pa	(b)	12/9	<.2	<.4	0	0
Escambia River:						
Century, Fla	4	12/31	.3	.3	0	0
Great Miami River:						
American Materials Bridge, Ohio	(c)	12/10	.9	.9	2	<1
Liberty Fairfield, Ohio	(c)	12/10	.8	.6	1	<1
Lost Bridge, Ohio	(c)	12/10	3.1	.9	16	3
Sellars Road, Ohio	(c)	12/10	1.1	.8	0	3
Kanawha River:						
Mason County, W. Va	4	12/31	<.3	<.8	5	10
Winfield Dam, W. Va	4	12/31	.3	.3	0	<1
Kentucky River:						
Lock #1, Ky	5	12/17	1.4	.9	1	1
Lake Erie:						
Buffalo, N. Y	4	12/17	.6	.6	19	28
Licking River:						
Covington, Ky	(b)	12/10	1.0	.4	2	1
Little Miami River:						
Cincinnati, Ohio	(b)	12/10	.2	.6	0	2
Maumee River:						
Toledo, Ohio	(b)	12/31	1.0	.9	22	25
Mississippi River:						
Lock and Dam, Minn	(c)	12/11	.3	.6	0	1
Burlington, Iowa	(c)	12/10	.3	.5	0	<1
	(c)	12/25	.6	1.0	0	<1
West Memphis, Ark	4	12/23	1.5	.4	0	0
Vicksburg, Miss	4	12/29	4.6	.9	3	0

See footnotes at end of table.

Table 1. Gross radioactivity in U.S. surface waters, January 1969-December 1970—continued

River and station	Sampling frequency [a]	Date	Gross alpha radioactivity (pCi /liter)		Gross beta radioactivity (pCi /liter)	
			Suspended solids	Dissolved solids	Suspended solids	Dissolved solids
		1969				
Missouri River:						
Omaha, Nebr	4	12/31	2.6	6.8	4	20
Yankton, S. Dak	(b)	12/12	<.2	6.8	0	<6
Williston N. Dak	4	12/22	5.8	15.5	5	18
Monongahela River:						
Pittsburgh, Pa	4	12/31	<.3	7.7	6	25
	4	12/31	<.3	<1.1	4	6
North Platte River:						
Henry, Nebr	(b)	12/1	.6	35.2	20	125
North Red River:						
Grand Forks, N. Dak	(b)	12/3	.3	1.2	0	<2
	4	12/31	.4	.8	0	<1
Ohio River:						
Addison, Ohio	4	12/31	<.3	<1.3	2	10
Anderson Ferry, Ohio	(b)	12/11	.5	.3	0	<3
Boyd County, Ky	4	12/31	<.3	.2	4	17
Cairo, Ill	(b)	12/8	.7	.3	0	<1
Cane Run, Ky	4	12/16	1.5	5.1	0	2
Cincinnati, Ohio	(b)	12/3	.2	.5	0	<3
	(b)	12/10	.3	<1.6	0	13
	(b)	12/10	.4	.5	0	<1
	(b)	12/17	3.7	.5	1	<1
	(b)	12/24	.6	<1.0	0	<1
	(b)	12/31	.9	.5	0	<1
East Liverpool, Ohio	4	12/31	.2	.2	5	8
Eldean, Ohio	(b)	12/10	.6	2.3	0	<3
Evansville, Ind	4	12/17	.6	.8	0	<1
Gallipolis, Ohio	4	12/31	.2	<1.4	2	9
Greenup Dam, Ky	(b)	12/10	.3	.4	0	<2
Ironton, Ohio	(b)	12/10	.2	.3	0	<1
Kyger Creek, W. Va	4	12/31	.4	.8	0	<3
Louisville, Ky	4	12/16	.4	1.1	0	<3
Madison, Ind	(b)	12/11	.3	.5	0	<3
Marietta, Ohio	4	12/31	.3	<1.8	0	<2
Markland Dam, Ky	(b)	12/10	.4	.6	0	1
Maysville, Ky	(b)	12/10	<.3	<.9	0	<1
Meldahl Dam, Ohio	(b)	12/10	.7	<1.0	0	<1
Miami Fort, Ohio	(b)	12/10	.6	.3	0	<1
Old Lock #19, W. Va	4	12/31	.5	.3	4	9
	4	12/31	.3	<.4	4	3
Portsmouth, Ohio	(b)	12/10	.5	.4	0	<1
South Heights, Pa	4	12/31	<.2	<1.3	5	15
Warwood, W. Va	4	12/31	<.2	.4	3	12
Platte River:						
Plattsmouth, Nebr	4	12/31	1.8	13.3	12	39
Potomac River:						
Williamsport, Md	(b)	12/29	.2	.2	0	0
Red River:						
Dennison, Tex	4	12/29	<.3	.3	0	0
Index, Ark	4	12/28	2.3	.4	1	0
Rio Grande:						
Brownsville, Tex	4	12/15	.6	1.6	0	<6
Laredo, Tex	4	12/29	1.2	2.7	0	<4
Sabine River:						
Ruliff, Tex	4	12/30	.9	.2	0	1
St. Clair River:						
Port Huron, Mich	(b)	12/31	<.3	<1.4	0	<2
St. Lawrence River:						
Massena, N.Y	(b)	12/1	.2	<.9	0	<1
	(b)	12/8	.2	<.9	0	<1
South Platte River:						
Julesburg, Colo	(b)	12/31	3.1	1.2	13	57
Tennessee River:						
Bridgeport, Ala	4	12/12	<.2	.4	0	2
Kentucky Dam, Ky	(b)	12/11	.9	.5	1	<1
Trinity River:						
Livingston, Tex	4	12/10	.7	.7	0	<1
Tombigbee River:						
Coumbus, Miss	4	12/22	1.4	.2	3	1
Verdigris River:						
Norwata, Okla	4	12/29	1.5	2.1	0	1
Wabash River:						
New Harmony, Ohio	4	12/17	1.4	.9	1	0
Whitewater River:						
Elizabethtown, Ohio	(b)	12/10	.5	1.3	1	<4

See footnotes at end of table.

Table 1. Gross radioactivity in U.S. surface waters, January 1969-December 1970—continued

River and station	Sampling frequency [a]	Date	Gross alpha radioactivity (pCi/liter)		Gross beta radioactivity (pCi/liter)	
			Suspended solids	Dissolved solids	Suspended solids	Dissolved solids
		1970				
Clinch River:						
Kingston, Tenn	(b)	1/12	0.3	0.7	7	9
	(b)	1/19	.3	1.1	5	15
	(b)	1/26	.4	.3	56	82
Licking River:						
Covington, Ky	(b)	1/14	<.2	.4	0	2
Little Miami River:						
Cincinnati, Ohio	(b)	1/14	.5	1.2	3	3
Mississippi River:						
Burlington, Iowa	3	1/14	.2	1.2	3	13
Ohio River:						
Cincinnati, Ohio	(b)	1/7	4.0	.3	4	2
	(b)	1/14	.2	<.3	0	0
	(b)	1/14	.4	.3	1	1
	(b)	1/22	.5	.4	4	5
	(b)	1/28	.4	<.4	8	7
Greenup Dam, Ky	(b)	1/14	<.6	.3	5	3
Ironton, Ohio	(b)	1/14	.6	.4	1	2
Markland Dam, Ky	(b)	1/14	1.3	.5	1	1
Maysville, Ky	(b)	1/14	1.0	.5	3	1
Meldahl Dam, Ohio	(b)	1/14	1.0	.4	4	1
Miami Fort, Ohio	(b)	1/14	1.5	.5	3	1
Portsmouth, Ohio	(b)	1/14	.3	.3	0	1
St. Lawrence River:						
Massena, N Y	(b)	1/5	.3	.5	0	<1
	(b)	1/12	<.2	.4	0	<1
	(b)	1/19	<.3	1.4	3	32
	(b)	1/26	<.2	.6	15	25
St. Mary River:						
Saulte St. Marie, Mich.	(b)	1/20	<.3	.4	6	9
Susquehanna River:						
Holtwood, Pa	(b)	1/7	.3	.3	14	25
Tennessee River:						
Kentucky Dam, Ky	(b)	1/14	4.1	.5	7	2
Great Miami River:						
American Materials Bridge, Ohio	(b)	2/11	1.0	2.0	4	14
Liberty Fairfield, Ohio	(b)	2/11	1.2	3.1	8	25
Lost Bridge, Ohio	(b)	2/11	1.1	3.2	5	13
Sellars Road, Ohio	(b)	2/11	.8	2.4	11	13
Licking River:						
Covington, Ky	(b)	2/12	1.8	.2	8	4
Little Miami River:						
Cincinnati, Ohio	(b)	2/11	1.0	.2	3	5
Mississippi River:						
Burlington, Iowa	3	2/12	.3	.9	3	5
West Memphis, Ark	4	2/16	4.3	.4	13	7
Ohio River:						
Anderson Ferry, Ohio	(b)	2/12	1.7	.2	5	11
Cincinnati, Ohio	(b)	2/11	4.0	.3	9	5
Eldean, Ohio	(b)	2/11	1.2	3.2	9	12
Madison, Idaho	(b)	2/12	1.9	.4	11	7
Markland Dam, Ky	(b)	2/12	2.5	.3	7	5
Maysville, Ky	(b)	2/11	3.8	.5	7	6
Meldahl Dam, Ohio	(b)	2/11	2.3	.3	10	5
Miami Fort, Ohio	(b)	2/11	2.4	.3	8	7
Portsmouth, Ohio	(b)	2/11	2.2	.3	5	4
St. Lawrence River:						
Massena, N.Y	(b)	2/2	.2	1.0	14	26
Tennessee River:						
Kentucky Dam, Ky	(b)	2/12	4.0	.4	21	6
Whitewater River:						
Elizabethtown Ohio	(b)	2/11	1.0	1.6	7	16
Allegheny River:						
Pittsburgh, Pa	4	3/31	<.2	.4	0	3
	4	3/31	1.1	.3	1	2
Arkansas River:						
Ponca City, Okla	4	3/30	.5	1.5	0	<3
Big Sandy River:						
Big Sandy, W. Va	4	3/31	.2	.6	0	4
Chattahoochee River:						
Columbus, Ga	4	3/30	.7	.2	0	2
Lanett, Ala	4	3/31	.4	<.3	0	2
Clinch River:						
Kingston, Tenn	(b)	3/9	.3	<.4	15	28
	(b)	3/16	.3	.4	15	24
	(b)	3/23	.3	.4	21	20
	(b)	3/30	<.2	.4	0	5
Coosa River:						
Rome, Ga	4	3/18	.3	.3	0	1
Cuyahoga River:						
Cleveland, Ohio	4	3/25	.3	2.5	2	10
Escambia River:						
Century, Fla	1	3/21	.5	<.3	1	2

See footnotes at end of table.

Table 1. Gross radioactivity in U.S. surface waters, January 1969-December 1970—continued

River and station	Sampling frequency [a]	Date	Gross alpha radioactivity (pCi /liter)		Gross beta radioactivity (pCi /liter)	
			Suspended solids	Dissolved solids	Suspended solids	Dissolved solids
		1970				
Guyadotte River:						
Guyadotte, W. Va.	4	3/31	0.3	<0.4	0	0
Kanawha River:						
Kanawha, W. Va.	4	3/31	.5	.3	0	4
Mason County, W. Va.	4	3/31	<.3	.4	0	2
Winfield Dam, W. Va.	4	3/31	.3	.4	0	0
Lake Erie:						
Buffalo, N.Y.	4	3/25	<.2	<.3	0	1
Licking River:						
Covington, Ky.	(b)	3/11	.3	.6	68	73
Maumee River:						
Toledo, Ohio	4	3/23	.4	<.6	1	6
Mississippi River:						
Vicksburg, Miss.	4	3/30	2.4	<.3	6	3
Monongahela River:						
Pittsburgh, Pa.	4	3/31	<.3	.4	0	2
	4	3/31	<.3	.6	7	13
Ohio River:						
Addison, Ohio	4	3/31	.6	<.6	1	3
Boyd County, Ky.	4	3/31	.6	.3	2	5
Cincinnati, Ohio	(b)	3/11	4.7	.3	21	19
	(b)	3/18	1.4	<.5	20	25
	(b)	3/25	.4	.2	0	2
	(b)	3/31	<.2	.3	0	4
East Liverpool, Ohio	4	3/26	1.3	<.5	32	19
Evansville, Ind.	4	3/31	.3	4.0	3	2
Gallipolis, Ohio	4	3/31	.3	.3	1	4
Kyger Creek, W. Va.	4	3/17	9.3	.3	91	23
Louisville, Ky.	4	3/31	<.2	.3	0	2
Marietta, Ohio	4	3/31	.3	.3	0	2
New Martinsville, Ohio	4	3/31	.3	<.5	0	3
Old Lock #19, W. Va.	4	3/31	<.3	.4	7	15
South Heights, Pa.						
Red River:						
Dennison, Tex.	4	3/30	.2	.3	0	0
Index, Ark.	4	3/31	3.1	.6	4	7
Rio Grande:						
Brownsville, Tex.	4	3/16	1.9	7.1	4	7
El Paso, Tex.	4	3/6	.3	.4	6	0
Laredo, Tex.	4	3/30	.2	4.1	0	10
Roanoke River:						
John Kerr Dam, Va.	(b)	3/9	<.2	.2	6	8
	(b)	3/16	<.2	.2	13	18
	(b)	3/23	.3	.2	7	12
	(b)	3/31	.3	1.5	0	5
St. Lawrence River:						
Massena, N.Y.	(b)	3/9	.2	.5	13	23
	(b)	3/16	<.2	.3	15	25
	(b)	3/23	<.2	.8	13	21
Sabine River:						
Ruliff, Tex.	4	3/31	.5	1.0	10	14
Tennessee River:						
Bridgeport, Ala.	4	3/18	<.2	.6	0	3
Trinity River:						
Livingston, Tex.	4	3/25	1.1	.7	3	9
Tombigbee, River:						
Columbus, Miss.	4	3/30	.6	.2	1	2
Verdigris River::						
Norwata, Okla.	4	3/30	<.2	4.8	0	29
Clinch, River:						
Kingston, Tenn.	(b)	4/13	.4	.9	12	30
	(b)	4/20	<.2	.4	9	19
Great Miami River:						
American Materials Bridge, Ohio	(b)	4/15	.7	1.0	8	24
Liberty Fairfield, Ohio	(b)	4/15	.3	2.7	0	4
Lost Bridge, Ohio	(b)	4/15	1.2	2.8	12	31
Sellars Road, Ohio	(b)	4/15	.5	3.0	0	5
Licking River:						
Covington, Ky.	(b)	4/15	.3	.5	0	4
Little Miami River:						
Cincinnati, Ohio	(b)	4/15	.6	.5	3	7
Mississippi River:						
Burlington, Iowa	(b)	4/16	1.4	.9	11	7
North Red River:						
Grand Forks, N. Dak.	(b)	4/2	<.2	.7	0	5
	(b)	4/9	3.2	.9	15	15
	(b)	4/17	1.8	2.3	23	30
	(b)	4/22	1.2	4.3	18	44
	(b)	4/29	2.4	4.3	15	35
Ohio River:						
Anderson Ferry, Ohio	(b)	4/15	1.5	.9	12	16
Cincinnati, Ohio	(b)	4/8	18.4	.4	76	11
	(b)	4/15	2.3	.3	7	4
	(b)	4/15	1.1	.4	5	5

See footnotes at end of table.

Table 1. Gross radioactivity in U.S. surface waters, January 1969-December 1970—continued

River and station	Sampling frequency [a]	Date	Gross alpha radioactivity (pCi /liter)		Gross beta radioactivity (pCi /liter)	
			Suspended solids	Dissolved solids	Suspended solids	Dissolved solids
		1970				
Ohio River:						
Cincinnati, Ohio	(c)	4/22	0.6	0.3	8	13
	(c)	4/29	3.9	.6	24	15
Eldean, Ohio	(b)	4/15	.5	2.7	1	4
Greenup, Dam, Ky	(b)	4/15	.8	.3	1	3
Ironton, Ohio	(b)	4/15	.9	.3	2	3
Madison, Ind	(b)	4/15	3.0	.8	8	3
Markland Dam, Ky	(b)	4/15	.7	.3	2	4
Maysville, Ky	(b)	4/15	.8	.3	3	4
Meldahl Dam, Ohio	(b)	4/15	.7	.9	2	2
Miami Fort, Ohio	(b)	4/15	1.2	.3	4	4
Portsmouth, Ohio	(b)	4/15	.7	.3	1	3
Roanoke River:						
John Kerr Dam, Va	(c)	4/6	<.2	.4	0	3
	(c)	4/20	.3	.4	7	14
	(b)	4/27	<.2	<.3	6	6
St. Lawrence River:						
Massena, N.Y	(c)	4/6	.4	.5	5	18
	(c)	4/13	<.2	.4	0	6
	(c)	4/20	.2	.3	7	15
	(b)	4/27	<.2	<.5	4	13
Susquehanna River:						
Holtwood, Pa	(b)	4/1	4.1	.2	30	12
Tennessee River:						
Kentucky Dam, Ky	(b)	4/15	1.2	2.0	3	3
Whitewater River:						
Elizabethtown, Ohio	(b)	4/15	.2	1.2	9	23
Clinch River:						
Kingston, Tenn	(b)	5/18	.2	.4	4	15
		5/25	<.2	.5	<3	3
Great Miami River:						
American Materials Bridge, Ohio	(c)	5/20	1.1	.4	5	14
Liberty Fairfield, Ohio	(c)	5/20	.6	1.5	3	10
Lost Bridge, Ohio	(c)	5/20	1.2	1.6	7	23
Sellars Road, Ohio	(c)	5/20	.8	1.0	5	9
Licking River:						
Covington, Ky	(b)	5/20	6.1	4.3	18	7
Little Miami River:						
Cincinnati, Ohio	(b)	5/20	.2	1.0	4	11
Mississippi River:						
Burlington, Iowa	(c)	5/14	6.0	1.0	35	13
Dubuque, Iowa	(c)	5/18	.4	1.6	12	20
North Red River:						
Grand Forks, N. Dak	(c)	5/7	1.6	3.8	15	38
	(c)	5/20	.4	4.3	3	46
	(c)	5/25	1.6	3.9	12	39
	(b)	5/27	.7	3.2	6	24
Ohio River:						
Anderson Ferry, Ohio	(b)	5/20	1.3	.4	5	5
Cincinnati, Ohio	(c)	5/6	1.9	<.5	10	8
	(c)	5/20	1.2	<.6	10	12
	(b)	5/20	1.1	<.6	7	4
	(b)	5/13	.3	<.6	5	9
	(b)	5/27	.4	.3	<3	8
Eldean, Ohio	(b)	5/20	.6	.3	4	11
Greenup Dam, Ky	(b)	5/20	.4	.4	3	9
Ironton, Ohio	(b)	5/21	1.7	<.8	6	5
Madison, Ind	(b)	5/20	.8	.4	8	7
Markland Dam, Ky	(b)	5/20	1.0	.2	9	7
Maysville, Ky	(b)	5/21	.7	<.8	4	5
Meldahl Dam, Ohio	(b)	5/20	.5	<.7	2	4
Miami Fort, Ohio	(b)	5/20	1.5	.8	7	5
Portsmouth, Ohio	(b)	5/21	.5	.3	9	10
Roanoke River:						
John Kerr Dam, Va	(c)	5/4	<.2	<.3	12	9
	(c)	5/11	.3	<.3	5	9
	(c)	5/18	<.2	<.3	5	8
	(b)	5/25	.2	<.3	<3	4
St. Lawrence River:						
Massena, N.Y	(c)	5/4	<.2	.3	5	10
	(c)	5/11	<.2	.2	6	9
	(c)	5/18	<.2	<.5	5	12
	(b)	5/25	<.2	<.5	2	6
Tennessee River:						
Kentucky Dam, Ky	(b)	5/20	.6	.4	11	4
Whitewater River:						
Elizabethtown, Ohio	(b)	5/20	.2	.3	3	4
Allegheny River:						
Pittsburgh, Pa	4	6/30	<.3	<.5	1	3
	4	6/30	<.2	<.5	0	5
	4	6/30	<.3	<.5	1	5
Alpheus Creek:						
Twin Falls, Ind	(b)	6/9	.2	1.5	0	18

See footnotes at end of table.

Table 1. Gross radioactivity in U.S. surface waters, January 1969-December 197)—continued

River and station	Sampling frequency [a]	Date	Gross alpha radioactivity (pCi /liter)		Gross beta radioactivity (pCi /liter)	
			Suspended solids	Dissolved solids	Suspended solids	Dissolved solids
		1970				
Arkansas River:						
Ponca City, Okla	4	6/30	1.8	2.6	41	19
Big Sandy River:						
Big Sandy, W. Va	4	6/30	.2	<.8	2	5
Big Sioux River:						
Sioux Falls, S. Dak	4	6/30	2.9	3.1	22	30
Chattahoochee River:						
Columbus, Ga	4	6/29	<.3	<.3	1	4
Lanett, Ala	4	6/29	<.3	<.3	1	4
Clinch River:						
Kingston, Tenn	[b]	6/2	.2	.2	0	5
	[b]	6/15	<.2	<.5	0	4
	[b]	6/23	<.2	<.3	0	6
	[b]	6/29	<.2	<.4	0	3
Coosa River:						
Rome, Ga	4	6/10	<.3	<.3	2	3
Cuyahoga River:						
Cleveland, Ohio	4	6/24	.4	4.3	6	23
Detroit River:						
Detroit, Mich	4	6/29	<.2	<.5	1	4
Great Miami River:						
American Materials Bridge, Ohio	[b]	6/17	.3	.6	4	12
Liberty Fairfield, Ohio	[b]	6/17	.3	.5	3	10
Sellars Road, Ohio	[b]	6/17	.3	.4	4	12
Green River:						
Spottsville, Ky	5	6/16	1.7	.3	6	6
Guyadotte River:						
Guyadotte, W. Va	4	6/30	<.3	<.8	0	6
Kanawha River:						
Mason County, W. Va	4	6/30	<.2	<.5	1	4
Winfield Dam, W. Va	4	6/30	<.3	<.6	1	3
Lake Erie:						
Buffalo, N.Y	4	6/24	<.2	<.5	1	6
Lake Superior:						
Duluth, Minn	[b]	6/1	<.2	.2	0	1
	5	6/1	.2	<.2	1	4
Licking River:						
Covington, Ky	[b]	6/17	1.1	.2	8	10
Little Miami River:						
Cincinnati, Ohio	[b]	6/17	.5	.5	10	19
Maumee River:						
Toledo, Ohio	4	6/24	.8	.9	8	11
Mississippi River:						
Lock and Dam, Minn	[b]	6/26	<.2	1.2	3	14
West Memphis, Ark	4	6/15	7.8	1.1	29	7
Vicksburg, Miss	4	6/29	2.2	<.4	14	7
Missouri River:						
Bismarck, N. Dak	4	6/29	1.6	1.8	10	15
Omaha, Nebr	4	6/30	2.8	3.6	11	15
St. Louis, Mo	4	6/23	3.3	2.4	20	30
Yankton, S. Dak	4	6/30	<.2	3.7	2	17
Monongahela River:						
Pittsburgh, Pa	4	6/30	<.2	<5.0	0	7
Muskingum River:						
Muskingum, Ohio	4	6/30	<.2	<1.2	0	6
North Platte River:						
Henry, Nebr	4	6/27	.4	14.3	4	34
North Red River:						
Grand Forks, N. Dak	[b]	6/10	2.4	1.4	14	25
	[b]	6/18	8.4	.3	62	17
	4	6/30	3.4	4.2	47	38
Ohio River:						
Addison, Ohio	4	6/30	.8	<.7	4	7
Beaver, Pa	4	6/30	<.3	<.9	1	12
Boyd County, Ky	4	6/30	<.2	<.8	1	5
Cane Run, Ky	4	6/15	1.5	.2	8	6
Cincinnati, Ohio	[b]	6/3	.2	.7	<3	7
	[b]	6/10	.3	.5	1	6
	[b]	6/16	<.2	<.7	1	6
	[b]	6/17	.5	.6	3	15
	[b]	6/24	.3	<.9	1	7
Eldean, Ohio	[b]	6/17	.6	1.8	5	8
Evansville, Ind	4	6/17	1.1	.3	12	7
Gallipolis, Ohio	4	6/30	<.3	<.7	3	6
Hancock, W. Va	4	6/30	<.2	<.6	0	5
Kyger Creek, W. Va	4	6/30	<1.1	<3.2	0	6
Louisville, Ky	4	6/15	.5	.4	4	7
Marietta, Ohio	4	6/30	<.2	<.8	0	6
Maysville, Ky	[b]	6/17	.9	<.5	5	7
Meldahl Dam, Ohio	[b]	6/17	.3	1.4	1	9
Miami Fort, Ohio	[b]	6/17	.7	<.5	4	5
New Martinsville, Ohio	4	6/30	<.3	<.9	1	5
Old Lock #19, W. Va	4	6/30	<.2	<.8	1	6
Portsmouth, Ohio	[b]	6/17	.5	<1.3	3	6

See footnotes at end of table.

Table 1. Gross radioactivity in U.S. surface waters, January 1969-December 1970—continued

River and station	Sampling frequency [a]	Date	Gross alpha radioactivity (pCi /liter)		Gross beta radioactivity (pCi /liter)	
			Suspended solids	Dissolved solids	Suspended solids	Dissolved solids
		1970				
Ohio River:						
South Heights, Pa	4	6/30	<0.3	<0.4	0	4
Warwood, W. Va	4	6/30	.3	<.6	1	5
Platte River:						
Plattsmouth, Nebr	4	6/30	5.3	10.5	35	27
Potomac River:						
Williamsport, Md	(b)	6/1	<.2	<.6	0	4
	4	6/30	<.3	.5	0	2
Red River:						
Dennison, Tex	4	6/30	<.3	.6	1	16
Index, Ark	4	6/29	3.2	.5	27	12
Rio Grande:						
Brownsville, Tex	4	6/29	<.3	1.5	1	17
El Paso, Tex	4	6/2	.2	2.9	4	25
Laredo, Tex	4	6/29	.6	1.5	4	14
Roanoke River:						
John Kerr Dam, Va	(b)	6/1	<.2	<.2	0	4
	(b)	6/8	.3	<.2	1	4
	(b)	6/15	<.2	<.2	0	4
	(b)	6/22	<.2	<.3	0	3
	(b)	6/29	<.2	<.3	0	4
Sabine River:						
Ruliff, Tex	4	6/30	.6	<.3	4	7
St. Clair River:						
Port Huron, Mich	5	6/29	<.2	<1.5	0	5
St. Lawrence River:						
Massena, N.Y	(b)	6/1	<.2	<.5	3	6
	(b)	6/8	<.2	.6	1	6
	(b)	6/22	<.2	<.6	0	6
St. Mary River:						
Saulte St. Marie, Mich	5	6/30	<.2	.2	0	3
Tennessee River:						
Bridgeport, Ala	4	6/24	<.3	<.4	2	3
Trinity River:						
Livingston, Tex	4	6/24	<.3	<.6	1	9
Tombigbee River:						
Columbus, Miss	4	6/29	.3	<.3	3	5
Verdigris River:						
Norwata, Okla	4	6/29	2.2	<.6	14	9
Whitewater River:						
Elizabethtown, Ohio	(b)	6/17	1.0	<.9	5	10
Wabash River:						
New Harmony, Ohio	4	6/17	5.8	.8	31	10
Allegheny River:						
Pittsburgh, Pa	3	7/8	<.2	.2	0	6
Big Sandy River:						
Big Sandy, W. Va	3	7/15	.4	.7	2	3
Clinch River:						
Kingston, Tenn	(b)	7/6	.4	2.2	7	13
	(b)	7/13	<.1	.2	1	4
	(b)	7/20	<.2	<.3	2	9
Great Miami River:						
American Materials Bridge, Ohio	(b)	7/15	.3	1.0	3	9
Liberty Fairfield, Ohio	(b)	7/15	.4	1.6	2	12
Lost Bridge, Ohio	(b)	7/15	.5	2.1	3	15
Sellars Road, Ohio	(b)	7/15	.2	1.3	2	11
Guyadotte River:						
Guyadotte, W. Va	3	7/15	.3	<.9	0	7
Licking River:						
Covington, Ky	(b)	7/15	.6	.4	2	9
Little Miami River:						
Cincinnati, Ohio	(b)	7/15	1.2	.6	7	9
Mississippi River:						
Burlington, Iowa	(b)	7/16	.4	1.4	3	11
Monongahela River:						
Pittsburgh, Pa	3	7/8	<.2	<.9	0	7
North Red River:						
Grand Forks, N. Dak	(b)	7/2	1.4	2.8	7	25
Ohio River:						
Anderson Ferry, Ohio	(b)	7/15	.2	<.4	2	
Beaver, Pa	3	7/9	.3	<.7	1	15
Boyd County Ky	3	7/15	.2	.2	2	1
Cincinnati, Ohio	(b)	7/1	<.2	<.8	1	8
	(b)	7/8	<.2	.2	1	18
	(b)	7/15	<.3	<.8	1	8
	(b)	7/16	.2	.3	1	9
	(b)	7/22	<.2	<.6	0	6
	(b)	7/29	<.2	<.7	1	9
Eldean, Ohio	(b)	7/15	1.0	2.2	4	12
Greenup Dam, Ky	(b)	7/16	.3	.2	5	12
Hancock, W. Va	3	7/9	.3	<.6	0	6
Ironton, Ohio	(b)	7/16	.3	<.6	3	7
Madison, Ind	(b)	7/15	.2	.4	1	9

See footnotes at end of table.

Table 1. Gross radioactivity in U.S. surface waters, January 1969-December 1970—continued

River and station	Sampling frequency [a]	Date	Gross alpha radioactivity (pCi /liter)		Gross beta radioactivity (pCi /liter)	
			Suspended solids	Dissolved solids	Suspended solids	Dissolved solids
		1970				
Ohio River:						
Markland Dam, Ky	(b)	7/15	<0.2	0.6	2	8
Maysville, Ky	(b)	7/16	.2	.3	2	8
Meldahl Dam, Ohio	(b)	7/16	.2	<.7	2	8
Miami Fort, Ohio	(b)	7/15	.7	.8	3	14
Portsmouth, Ohio	(b)	7/16	.2	.5	1	7
South Heights, Pa	3	7/6	<.2	<.6	0	6
Roanoke River:						
John Kerr Dam, Va	(b)	7/6	<.3	<.3	0	3
	(b)	7/13	<.2	.2	0	4
	(b)	7/20	.3	.2	1	3
	(b)	7/27	.2	<.2	1	4
St. Lawrence River:						
Massena, N. Y	(b)	7/20	<.3	<.6	3	7
	(b)	7/13	<.2	<.4	1	7
	(b)	7/27	<.2	.5	2	13
Susquehanna River:						
Holtwood, Pa	(b)	7/1	.5	.2	2	6
Tennessee River:						
Kentucky Dam, Ky	(b)	7/15	<.2	.4	2	9
Whitewater River:						
Elizabethtown, Ohio	(b)	7/15	.4	.6	7	18
Yellowstone River:						
Sidney, Mont	(b)	7/7	<.3	1.8	0	10
Clinch River:						
Kingston, Tenn	(b)	8/17	.3	.2	2	10
	(b)	8/24	<.2	.4	1	5
	(b)	8/31	.2	.2	1	5
Mississippi River:						
Cape Girardeau, Mo	(b)	8/13	3.0	1.3	11	14
North Red River:						
Grand Forks, N. Dak	(b)	8/10	.8	2.6	5	29
		8/20	.6	2.7	5	32
Ohio River:						
Cincinnati, Ohio	(b)	8/5	<.2	.2	2	18
	(b)	8/12	<.2	.6	2	17
	(b)	8/19	<.2	<.8	1	9
	(b)	8/19	<.2	.4	1	11
	(b)	8/26	.3	.5	3	14
Roanoke River:						
John Kerr Dam, Va	(b)	8/3	<.2	<.2	1	4
	(b)	8/3	<.2	<.2	1	6
	(b)	8/10	.2	<.2	3	8
	(b)	8/17	.3	<.2	3	6
	(b)	8/24	1.2	.2	7	6
	(b)	8/31	<.2	<.2	2	3
	(b)	8/31	<.2	<.2	1	4
Allegheny River:						
Pittsburgh, Pa	4	9/30	<.2	.5	0	3
Arkansas River:						
Ponca City, Okla	4	9/28	2.2	7.9	5	28
Chattahoochee River:						
Columbus, Ga	4	9/28	.5	1.2	0	2
Lanett, Ala	4	9/28	.8	.4	0	1
Clinch River:						
Kingston, Tenn	(b)	9/7	.2	.2	0	3
	(b)	9/14	.2	.2	0	4
	(b)	9/21	.2	.3	3	0
	(b)	9/28	<.2	<.3	4	0
Cuyahoga River:						
Cleveland, Ohio	4	9/30	1.4	7.5	7	19
Great Miami River:						
American Materials Bridge, Ohio	(b)	9/23	.2	1.5	0	10
Liberty Fairfield, Ohio	(b)	9/23	.3	.5	0	6
Lost Bridge, Ohio	(b)	9/23	.9	1.0	3	27
Sellars Road, Ohio	(b)	9/23	<.2	1.7	0	6
Kanawha River:						
Mason County, W. Va	4	9/15	<.2	.6	1	0
Winfield Dam, W. Va	4	9/30	.3	.2	1	1
Lake Erie:						
Buffalo, N.Y	4	9/30	.2	.4	0	3
Licking River:						
Covington, Ky	(b)	9/23	.2	.3	0	8
Little Miami River:						
Cincinnati, Ohio	(b)	9/23	.8	.4	4	4
Maumee River:						
Toledo, Ohio	4	9/30	.5	1.1	0	6
Mississippi River:						
Burlington, Iowa	(b)	9/11	.8	1.2	1	7
West Memphis, Ark	4	9/28	.9	1.8	2	7
Vicksburg, Miss	4	9/28	.6	.3	0	4

See footnotes at end of table.

Table 1. Gross radioactivity in U.S. surface waters, January 1969-December 1970—continued

River and station	Sampling frequency [a]	Date	Gross alpha radioactivity (pCi/liter)		Gross beta radioactivity (pCi/liter)	
			Suspended solids	Dissolved solids	Suspended solids	Dissolved solids
		1970				
Missouri River:						
Omaha, Nebr.	4	9/30	0.2	3.5	0	16
Monongahela River:						
Pittsburgh, Pa.	4	9/30	<.2	<.7	0	3
Muskingum River:						
Lock #2, Ohio	4	9/14	.2	.3	2	3
Ohio River:						
Addison, Ohio	4	9/30	<.2	.5	1	5
Anderson Ferry, Ohio	(b)	9/23	.2	.3	1	7
Cane Run, Ky.	4	9/15	.2	1.7	0	6
Cincinnati, Ohio	(b)	9/2	<.2	.5	0	4
	(b)	9/9	.2	<.6	0	5
	(b)	9/9	.2	.2	1	2
	(b)	9/16	<.2	.3	0	3
	(b)	9/23	<.2	.4	0	3
	(b)	9/30	.2	.6	0	5
Eldean, Ohio	(b)	9/23	.8	.4	1	7
Evansville, Ind.	4	9/24	.5	.8	1	6
Gallipolis, Ohio	3	9/15	<.2	.4	0	4
	3	9/15	<.2	.3	0	0
Greenup Dam, Ky.	(b)	9/24	.2	1.4	0	5
Ironton, Ohio	(b)	9/24	<.2	1.4	0	6
Kyger Creek, W. Va.	4	9/15	<.2	.3	2	1
Louisville, Ky.	4	9/15	<.2	1.1	0	7
Madison, Ind.	(b)	9/23	.2	.3	0	3
Marietta, Ohio	4	9/14	.2	.2	2	2
Markland Dam, Ky.	(b)	9/23	.3	.5	0	7
Maysville, Ky.	(b)	9/24	.7	.4	0	6
Meldahl Dam, Ohio	(b)	9/24	.2	.3	0	6
Miami Fort, Ohio	(b)	9/23	.5	.3	0	4
New Martinsville, Ohio	3	9/14	<.2	.5	0	5
	3	9/14	<.2	<.7	3	0
Old Lock #19, W. Va.	4	9/15	.2	.6	1	1
Portsmouth, Ohio	(b)	9/24	.3	.4	0	5
Warwood, W. Va.	4	9/30	.3	<.6	0	6
Platte River:						
Plattsmouth, Nebr.	4	9/30	.3	9.4	0	36
Red River:						
Index, Ark.	4	9/29	.6	3.8	2	24
Rio Grande:						
Brownsville, Tex.	4	9/28	.5	4.8	1	10
El Paso, Tex.	4	9/9	16.2	6.1	51	8
Laredo, Tex.	4	9/28	1.3	8.4	4	4
Roanoke River:						
John Kerr Dam, Va.	(b)	9/8	.3	<.2	0	2
	(b)	9/8	.3	<.2	0	2
	(b)	9/14	.2	.2	0	2
	(b)	9/21	.2	<.2	0	3
	(b)	9/28	.4	<.2	4	0
Sabine River:						
Ruliff, Tex.	4	9/29	.7	.3	0	5
St. Lawrence River:						
Massena, N.Y.	(b)	9/8	<.1	.3	1	2
	(b)	9/8	<.1	.5	0	4
	(b)	9/14	.4	.2	1	4
	(b)	9/21	<.2	.6	0	5
	(b)	9/28	<.2	.4	0	5
Tennessee River:						
Bridgeport, Ala.	4	9/30	.3	.7	0	2
Kentucky Dam, Ky.	(b)	9/23	.2	.2	0	4
Trinity River:						
Livingston, Tex.	4	9/8	.4	1.0	0	2
Tombigbee River:						
Columbus, Miss.	4	9/28	.5	.5	0	2
Verdigris River:						
Norwata, Okla.	4	9/28	.7	1.1	2	3
Wabash River:						
New Harmony, Ohio	4	9/24	.9	1.1	3	6
Whitewater River:						
Elizabethtown, Ohio	(b)	9/23	.9	1.4	3	3
Big Horn River:						
Hardin, Mont.	(b)	10/2	<.2	4.6	3	37
Clinch River:						
Kingston, Tenn.	(b)	10/5	<.2	.2	0	3
	(b)	10/12	<.2	.4	0	3
	(b)	10/19	<.2	.2	0	4
	(b)	10/26	<.2	.4	0	2
Great Miami River:						
American Materials Bridge, Ohio	(b)	10/14	.6	.7	8	10
Liberty Fairfield, Ohio	(b)	10/14	.3	.5	2	11
Lost Bridge, Ohio	(b)	10/14	.9	2.1	6	10
Sellars Road, Ohio	(b)	10/14	.5	2.1	4	12
Licking River:						
Covington, Ky.	(b)	10/14	<.3	.5	2	8

See footnotes at end of table.

Table 1. Gross radioactivity in U.S. surface waters, January 1969-December 1970—continued

River and station	Sampling frequency [a]	Date	Gross alpha radioactivity (pCi /liter)		Gross beta radioactivity (pCi /liter)	
			Suspended solids	Dissolved solids	Suspended solids	Dissolved solids
		1970				
Little Miami River:						
Cincinnati, Ohio	(b)	10/14	1.2	1.6	7	10
Mississippi River:						
Burlington, Iowa	(b)	10/8	.8	.4	3	7
Ohio River:						
Anderson Ferry, Ohio	(b)	10/14	.4	1.0	1	8
Cincinnati, Ohio	(b)	10/7	.6	<.9	1	9
	(b)	10/14	1.4	.3	5	5
	(b)	10/15	.2	.3	2	6
	(b)	10/21	.2	.4	0	7
	(b)	10/19	.2	.3	1	9
	(b)	10/28	.3	.4	0	5
Eldean, Ohio	(b)	10/14	.4	3.0	2	12
Greenup Dam, Ky	(b)	10/15	.4	.7	2	8
Ironton, Ohio	(b)	10/15	.3	.4	1	8
Madison, Ind	(b)	10/14	.4	1.1	1	9
Markland Dam, Ky	(b)	10/14	.6	.4	2	9
Maysville, Ky	(b)	10/15	4.6	.5	12	8
Meldahl Dam, Ohio	(b)	10/15	.2	.3	2	8
Miami Fort, Ohio	(b)	10/14	.4	.4	3	7
Portsmouth, Ohio	(b)	10/15	.4	.3	2	8
Roanoke River:						
John Kerr Dam, Va	(b)	10/5	.3	<.2	0	5
	(b)	10/13	<.2	.2	0	3
	(b)	10/19	<.2	.2	0	3
	(b)	10/25	<.1	.2	0	4
St. Lawrence River:						
Massena, N.Y	(b)	10/5	<.2	<.4	0	6
	(b)	10/19	.3	.3	0	5
	(b)	10/26	.2	.2	1	5
Susquehanna River:						
Holtwood, Pa	(b)	10/7	.4	.4	1	4
Tennessee River:						
Kentucky Dam, Ky	(b)	10/14	2.1	1.1	7	7
Whitewater River:						
Elizabethtown, Ohio	(b)	10/14	.3	.5	2	8
Clinch River:						
Kingston, Tenn	(b)	11/2	<.2	.2	0	9
	(b)	11/9	.3	.9	0	5
	(b)	11/16	.3	.5	0	7
	(b)	11/23	.4	.2	3	5
	(b)	11/20	.4	.5	5	4
Great Miami River:						
American Materials Bridge, Ohio	(b)	11/18	.2	2.0	1	9
Liberty Fairfield, Ohio	(b)	11/18	.4	1.5	2	10
Lost Bridge, Ohio	(b)	11/18	<.2	1.7	1	8
Sellars Road, Ohio	(b)	11/18	.7	1.3	2	9
Licking River:						
Covington, Ky	(b)	11/18	.5	.3	2	3
Little Miami River:						
Cincinnati, Ohio	(b)	11/18	.6	1.1	2	8
Mississippi River:						
Dubuque, Iowa	(b)	11/13	1.9	1.7	5	6
Missouri River:						
St. Joseph, Mo	(b)	11/25	.3	7.7	0	15
Ohio River:						
Anderson Ferry, Ohio	(b)	11/18	1.0	.2	3	7
Cincinnati, Ohio	(b)	11/4	3.4	.2	9	4
	(b)	11/12	1.1	1.2	2	4
	(b)	11/19	.5	.3	3	5
	(b)	11/18	1.7	.6	2	4
	(b)	11/24	1.1	.7	3	4
Eldean, Ohio	(b)	11/18	<.4	.8	2	7
Greenup Dam, Ky	(b)	11/19	.7	.3	2	5
Ironton, Ohio	(b)	11/19	.7	<.5	3	5
Madison, Ind	(b)	11/18	1.3	.2	3	5
Markland Dam, Ky	(b)	11/18	.5	.3	2	7
Maysville, Ky	(b)	11/19	1.4	.2	3	5
Meldahl Dam, Ohio	(b)	11/19	1.0	.2	3	3
Portsmouth, Ohio	(b)	11/19	.6	.3	4	6
Roanoke River:						
John Kerr Dam, Va	(b)	11/2	<.2	.3	0	3
	(b)	11/9	.4	.8	0	4
	(b)	11/16	.5	.4	0	3
	(b)	11/23	.7	.6	1	5
	(b)	11/30	.3	.3	0	5
St. Lawrence River:						
Massena, N.Y	(b)	11/2	<.2	.6	0	5
	(b)	11/15	.9	.8	1	5
	(b)	11/23	.5	.6	0	5
	(b)	11/30	.6	.5	1	6
Tennessee River:						
Kentucky Dam, Ky	(b)	11/18	1.6	.6	5	4

See footnotes at end of table.

Table 1. Gross radioactivity in U.S. surface waters, January 1969-December 1970—continued

River and station	Sampling frequency [a]	Date	Gross alpha radioactivity (pCi /liter)		Gross beta radioactivity (pCi /liter)	
			Suspended solids	Dissolved solids	Suspended solids	Dissolved solids
		1970				
Whitewater River:						
Elizabethtown, Ohio	(b)	11/18	0.3	1.7	0	6
Allegheny River:						
Pittsburgh, Pa	4	12/14	<.3	.2	3	5
	4	12/16	.3	.3	3	4
Arkansas River:						
Ponca City, Okla	4	12/28	1.9	7.0	7	23
Beaver River:						
Rt. 18 Bridge, Pa	4	12/15	1.0	<.6	4	11
Big Sandy River:						
Big Sandy, W. Va	4	12/16	.6	.4	4	8
Big Sioux River:						
Sioux Falls, S. Dak	4	12/22	.5	1.0	4	28
Clinch River:						
Kingston, Tenn	(b)	12/7	.3	1.3	2	11
	(b)	12/18	.2	.6	2	9
Cuyahoga River:						
Cleveland, Ohio	4	12/30	1.0	4.2	8	23
Detroit River:						
Detroit, Mich	5	12/31	.2	.3	2	6
Great Miami River:						
Lost Bridge, Ohio	(b)	12/16	<.2	.8	3	8
Green River:						
Spottsville, Ky	5	12/16	1.3	1.1	4	9
Guyadotte River:						
Guyadotte, W. Va	4	12/16	.2	.8	2	7
Kanawha River:						
Mason County, W. Va	4	12/15	.4	<.4	3	5
Winfield Dam, W. Va	4	12/16	.7	<.4	4	5
Lake Erie:						
Buffalo, N.Y	4	12/30	.5	.3	5	7
Lake Superior:						
Duluth, Minn	(b)	12/23	.2	.3	2	6
	5	12/31	.3	<.3	0	2
Licking River:						
Covington, Ky	(b)	12/16	.8	<.4	8	10
Little Miami River:						
Cincinnati, Ohio	(b)	12/16	.6	2.0	4	12
Maumee River:						
Toledo, Ohio	4	12/23	.9	1.2	4	13
Mississippi River:						
Lock and Dam, Minn	5	12/31	.2	2.4	3	11
Burlington, Iowa	(b)	12/17	.5	3.7	2	6
West Memphis, Ark	4	12/28	1.9	1.5	8	10
Vicksburg, Miss	4	12/28	2.2	.4	7	5
Missouri River:						
Yankton, S. Dak	4	12/23	1.0	.7	3	16
Monongahela River:						
Pittsburgh, Pa	4	12/14	<.2	.3	2	9
	4	12/14	.5	<.6	2	8
Muskingum River:						
Lock #2, Ohio	(b)	12/14	.3	.6	4	13
Ohio River:						
Addison, Ohio	(b)	12/16	1.4	<.6	6	7
Anderson Ferry, Ohio	(b)	12/16	1.0	<.4	8	6
Boyd County, Ky	4	12/16	.8	<.6	5	7
Cane Run, Ky	4	12/15	.8	.6	6	11
Cincinnati, Ohio	(b)	12/2	.6	.3	3	7
	(b)	12/9	.6	<.5	3	7
	(b)	12/16	1.8	.4	8	5
	(b)	12/17	.8	.2	10	6
	(b)	12/23	7.1	.4	26	8
	(b)	12/30	1.8	.3	9	7
Eldean, Ohio	(b)	12/16	.7	1.6	2	7
Evansville, Ind	4	12/29	2.7	<.6	9	7
Gallipolis, Ohio	(b)	12/15	.7	.3	5	8
Greenup Dam, Ky	(b)	12/17	2.4	.2	7	6
Hancock, W. Va	4	12/15	.3	<.4	5	5
Ironton, Ohio	(b)	12/17	.8	<.4	7	6
Kyger Creek, W. Va	4	12/15	.7	<.6	4	8
Louisville, Ky	4	12/15	.8	.6	3	9
Madison, Ind	(b)	12/16	.9	.2	8	7
Marietta, Ohio	4	12/14	.6	<.6	5	8
Markland Dam, Ky	(b)	12/16	.7	<.4	6	7
Maysville, Ky	(b)	12/17	2.0	.2	10	7
Meldahl Dam, Ohio	(b)	12/17	.4	.5	4	6
Miami Fort, Ohio	(b)	12/16	2.6	.2	10	6
New Martinsville, Ohio	4	12/14	.5	.4	3	7
Old Lock #19, W. Va	4	12/14	.7	<.6	3	7
Portsmouth, Ohio	(b)	12/17	3.9	.2	9	7
South Heights, Pa	4	12/14	.2	<.4	2	6
Warwood, W. Va	4	12/16	<.3	<.5	3	7

See footnotes at end of table.

Table 1. Gross radioactivity in U.S. surface waters, January 1969-December 1970—continued

River and station	Sampling frequency [a]	Date	Gross alpha radioactivity (pCi /liter)		Gross beta radioactivity (pCi /liter)	
			Suspended solids	Dissolved solids	Suspended solids	Dissolved solids
Red River:						
Dennison, Tex	4	12/28	0.3	1.2	2	19
Index, Ark	4	12/28	3.1	.8	10	12
Rio Grande:						
Brownsville, Tex	4	12/28	.2	3.1	3	21
El Paso, Tex	4	12/28	.4	2.8	3	18
Laredo, Tex	4	12/28	.4	2.5	4	15
Roanoke River:						
John Kerr Dam, Va	(b)	12/7	.3	.3	1	5
	(b)	12/14	.3	.3	2	6
	(b)	12/21	<.2	<.3	2	6
	(b)	12/28	.2	.3	2	6
Sabine River:						
Ruliff, Tex	4	12/24	2.1	.4	6	7
St. Lawrence River:						
Massena, N.Y	(b)	12/7	.5	.7	4	7
	(b)	12/14	.3	.5	2	8
	(b)	12/21	.2	.5	2	7
	(b)	12/28	.3	.4	2	7
Tennessee River:						
Kentucky Dam, Ky	(b)	12/16	.8	<.5	6	8
Trinity River:						
Livingston, Tex	4	12/31	.9	1.8	5	17
Verdigris River:						
Norwata, Okla	4	12/28	<.3	2.6	3	12
Wabash River:						
New Harmony, Ohio	(b)	12/29	1.1	1.1	6	12
Whitewater River:						
Elizabethtown, Ohio	(b)	12/16	.4	1.0	2	9

[a] Sampling frequency: 1—grab sample; 2—weekly; 3—monthly; 4—quarterly; 5—semiannual; 6—annual.
[b] Sampling frequency not recorded.

Tritium Surveillance Systems, January-March 1973

Office of Radiation Programs
Environmental Protection Agency

The Tritium Surveillance System is an expansion of previous tritium surveillance activities initiated by the Public Health Service and transferred in 1970 to the Office of Radiation Programs, Environmental Protection Agency (EPA). The principal effort in the past related to tritium releases was the Tritium in Surface Water Network. This network was established in 1964 to measure and monitor tritium concentrations in major river systems in the United States and to provide surveillance at surface water stations downstream from selected nuclear facilities. The network consisted of selected stations from the existing water pollution surveillance sampling stations. The final data from this network for January–June 1970, have been published previously (*1*).

Another sampling program of the Public Health Service was a tritium in precipitation program. This project was established in 1967 at selected Radiation Alert Network (RAN) stations covering the United States, including Alaska and Hawaii. The RAN is now operated by the Office of Air Programs of the EPA. The data from this project for July–December 1969 have been published previously (*2*). Due to the increased interest in tritium releases from nuclear facilities and the potential long-term accumulation in the environment, a national system was established to incorporate these projects or networks into one overall system.

Present network

The Tritium Surveillance System consists of 68 quarterly drinking water samples at the RAN stations, precipitation samples collected daily and analyzed monthly from 8 of the RAN stations (figure 1), and quarterly samples at 39 surface water stations (figure 2). The specific locations for the surface water sampling system were determined by examining the water

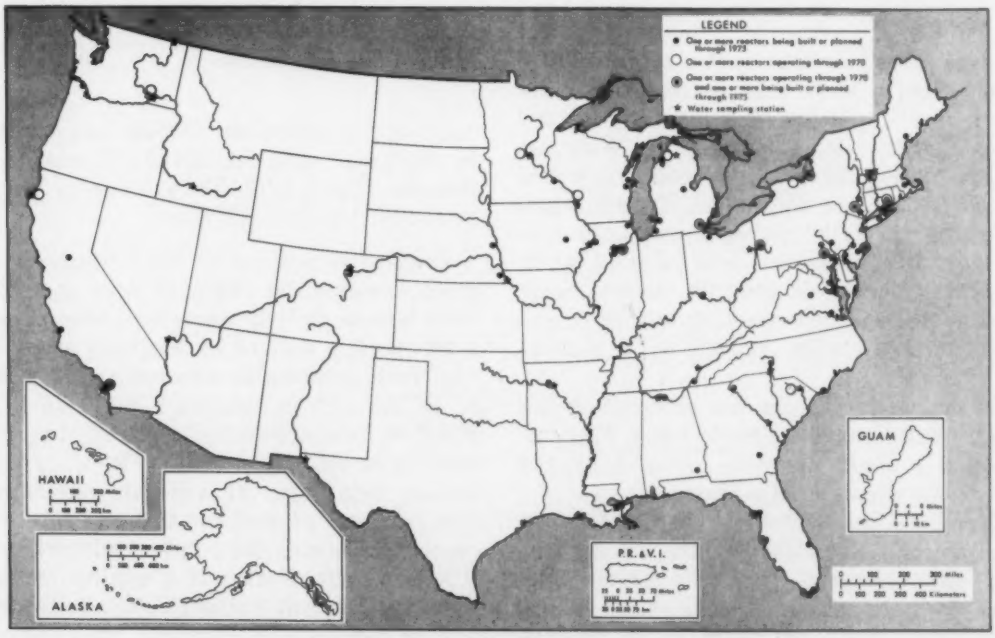

Figure 1. Drinking water and precipitation sampling locations for tritium surveillance system

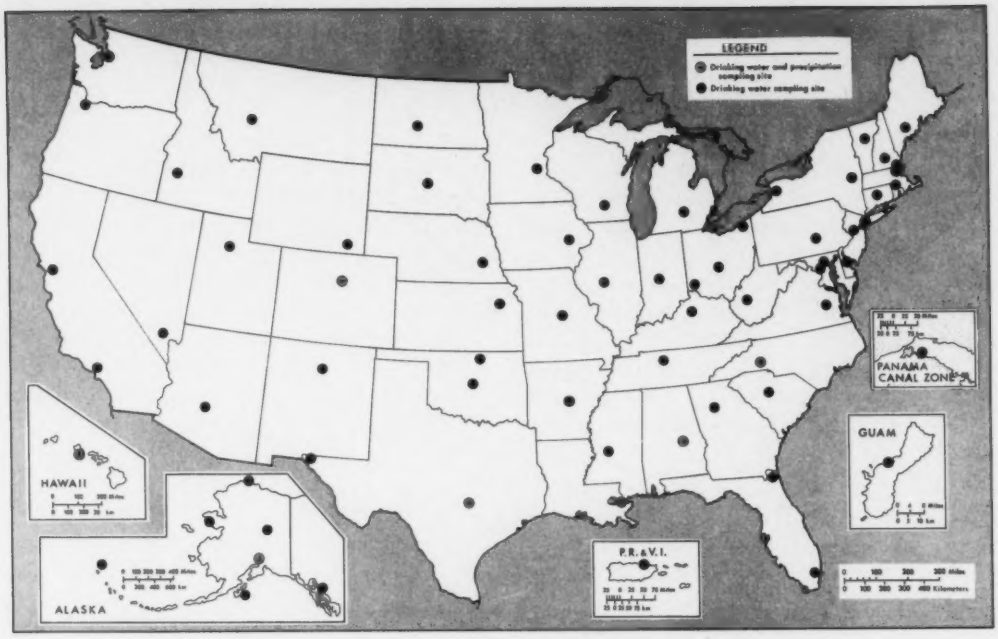

Figure 2. Surface water sampling locations for tritium surveillance system

drainage areas to assure that a representative sample from a large area or region was obtained, and if possible, incorporating several nuclear facility sites. All nuclear facilities that were operating, being constructed, or planned through 1975 were considered. Consideration was also given to the current surveillance programs of the States that will be involved in the collection of the samples. The surface water samples are collected quarterly either downstream from a nuclear facility or at a background station.

The tap water samples are collected by the RAN operators on a quarterly basis. The precipitation samples are also collected by the RAN operators on a daily basis.

All samples are sent to either the Eastern Environmental Radiation Facility or the National Environmental Research Center—Las Vegas, for analysis. Analytical values which are not statistically significant at the 2-sigma confidence level have been reported as zero.

Results and discussion

Table 1 presents the tritium concentrations in drinking water at the RAN stations for January–March 1973. The average tritium concentration was 0.2 nCi/liter.

In previous articles on the Tritium Surveillance Systems, the reported dose equivalents from tritium in body water have been based on a relationship derived by Moghissi and Porter (*3*). Their relationship assumed a quality factor of 1.7 for tritium beta rays based on a 1966 ICRP recommendation (*4*). Recently the NCRP has recommended a quality factor of 1 for tritium beta rays (*5*) and this recommendation has been adopted for this and subsequent reports. Following the notation adopted by the ICRU (*6*) substitution of a quality factor of 1 in Moghissi and Porter's calculations yields:

$$H \text{ (mrem/year)} = 0.1C \text{ (nCi/liter)}$$

Table 1. Tritium concentration in tap water, (RAN stations), January-March 1973

Location	Date collected (1973)	Tritium concentration[a] (nCi/liter ± 2σ)[b]
Ala: Montgomery	1/2	0
Alaska: Anchorage	1/8	0.7
Attu Island	1/2	.3
Fairbanks	2/26	.7
Juneau	1/1	.3
Nome	2/15	.5
Point Barrow	1/28	.8±0.3
Ariz: Phoenix	1/8	.2
Ark: Little Rock	1/2	0
Calif: Berkeley	1/2	0
Los Angeles	1/8	.3
C.Z: Ancon	2/5	0
Colo: Denver	1/8	.9
Conn: Hartford	1/9	0
Del: Dover	1/5	0
D.C: Washington	2/12	.2
Fla: Jacksonville	1/4	0
Miami	1/8	0
Ga: Atlanta	1/10	.2
Guam: Agana	1/2	0
Hawaii: Honolulu	1/2	0
Idaho: Boise	1/9	.5
Ill: Springfield	1/11	.2
Ind: Indianapolis	NS	
Iowa: Iowa City	1/4	.6
Kans: Topeka	1/2	0
Ky: Frankfort	2/6	0
La: New Orleans	1/4	.5
Maine: Augusta	1/8	0
Md: Baltimore	1/4	.2
Mass: Lawrence	1/8	.2
Winchester	1/5	.2
Mich: Lansing	1/5	0
Minn: Minneapolis	1/11	.6
Miss: Jackson	1/5	0
Mo: Jefferson City	1/3	0
Mont: Helena	1/11	.8± .3
Nebr: Lincoln	1/22	0
Nev: Las Vegas	1/4	.9
N.H: Concord	1/9	.2
N.J: Trenton	1/4	0
N. Mex: Sante Fe	1/12	0
N.Y: Albany	NS	
Buffalo	1/10	.4
New York City	1/4	.3
N.C: Gastonia	1/5	0
N. Dak: Bismarck	2/26	.8± .3
Ohio: Cincinnati	1/5	.2
Columbus	1/5	.2
Painesville	NS	
Okla: Oklahoma City	1/2	0
Oreg: Portland	1/5	0
Pa: Harrisburg	1/9	0
P.R: San Juan	1/10	0
R.I: Providence	1/5	0
S.C: Columbia	1/4	.2
S. Dak: Pierre	1/2	.9
Tenn: Nashville	1/5	0
Tex: Austin	1/4	0
El Paso	1/3	0
Utah: Salt Lake City	1/10	.9
Vt: Barre	1/5	.2
Va: Richmond	1/4	.3
Wash: Seattle	1/15	.2
Spokane	1/2	.3
W. Va: Charleston	1/4	.2
Wisc: Madison	1/5	0
Wyo: Cheyenne	1/3	.8
Average		0.2

[a]The minimum detection limit for all samples was 0.20 nCi/liter. All values equal to or less than 0.20 nCi/liter before rounding have been reported as zero.
[b]The 2σ error for all samples is 0.2 nCi/liter unless otherwise noted.
NS, no sample.

Where H is the dose equivalent rate and C represents the tritium concentration in body water.

Assuming that the concentration of tritium in all water taken into the body is equal to that found in the drinking water and also that the specific activity of tritium in the body is essentially the same as that in the drinking water, then the radiation dose may be estimated.

The highest individual concentration of tritium observed in the drinking water was 0.9 nCi/liter during the first quarter. This corresponds to a dose of 0.09 mrem/a, or less than 0.06 percent of the Federal Radiation Council's Radiation Protection Guide (170 mrem/a) for an average dose to a suitable sample of the exposed population.

The tritium concentrations for the surface water samples are given in table 2. The highest tritium concentration was 10.4 nCi/liter for the quarter. Assuming that the specific activity of tritium in the body is essentially the same as that in surface water, this concentration corresponds to a dose of 1.04 mrem/a, or 0.61 percent of the Radiation Protection Guide.

The monthly analyses for tritium in precipitation samples at the 8 RAN stations are shown in table 3.

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(2) BUREAU OF RADIOLOGICAL HEALTH. Tritium in precipitation (RAN), July–December 1969. Radiol Health Data Rep 11:354–355 (July 1970).

(3) MOGHISSI, A. A. and C. R. PORTER. Tritium in surface waters in the United States, 1966. Radiol Health Data Rep 9:337–339 (July 1968).

(4) INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, Recommendations of the International Commission on Radiological Protection (Adopted September 17, 1965), ICRP Publication 9 (1969).

(5) NATIONAL COUNCIL ON RADIATION PROTECTION AND MEASUREMENTS. Basic radiation protection criteria, NCRP Report No. 39. National Council on Radiation Protection and Measurements, Washington, D.C. 20008 (January 15, 1971).

(6) INTERNATIONAL COMMISSION ON RADIATION UNITS AND MEASUREMENTS, Radiation Quantities and Units, ICRU Report No. 19. Washington, D.C. 20014 (July 1972).

Table 2. Tritium concentration in surface water, January-March 1973

Location	Water source	Facility	Collection date (1973)	Concentration[a] (nCi/liter ±2σ)[b]
Ala: Decatur	Tennessee River	Browns Ferry	1/24	0.2
Ark: Morrilton	Arkansas River	Arkansas Nuclear	1/12	0
Calif: Eureka	Humboldt Bay	Humboldt Bay	1/17	0
San Onofre	Pacific Ocean	San Onofre	NS	
Colo: Greely	South Platte River	Fort St. Vrain	1/12	.9
Conn: East Haddam	Connecticut River	Connecticut Yankee & Vermont Yankee	1/19	1.9
Waterford	Long Island Sound	Millstone	1/19	0
Fla: Crystal River	Gulf of Mexico	Crystal River	1/26	0
Homestead	Biscayne Bay	Turkey Point	1/9	0
Idaho: Buhl	Snake River	National Reactor Testing Station	1/8	.6
Ill: Moline	Mississippi River	Quad-Cities	1/31	.2
Morris	Illinois River	Dresden and Argonne	1/19	.2
La: New Orleans	Mississippi River	(Several)	1/3	.3
Md: Conowingo	Susquehanna River	Peach Bottom and Three Mile Island	1/9	.2
Lusby	Chesapeake Bay	Calvert Cliffs	1/30	0
Mass: Rowe	Deerfield River	Yankee	1/25	2.2
Mich: Charlevoix	Lake Michigan	Big Rock Point	1/14	0
Monroe	Lake Erie	Enrico Fermi	1/14	.3
South Haven	Lake Michigan	Palisades	1/26	1.0
Minn: Monticello	Mississippi	Monticello	1/11	.7
Nebr: Rulo	Missouri River	Fort Calhoun and Cooper	1/17	.6
Nev: Boulder City	Colorado River	Background	1/9	1.0± .3
N.J: Bayside	Delaware River	Salem	1/18	.2
N.Y: Ossining	Hudson River	Indian Point	1/5	.2
Oswego	Lake Ontario	Nine Mile Point and R.E. Ginna	1/9	.4
Poughkeepsie	Hudson River	Background	1/10	0
N.C: Charlotte	Catawba River	Wm. B. McGuire	1/16	.2
Oreg: Westport	Columbia River	Rainier and Hanford	NS	
S.C: Allendale	Savannah River	Savannah River Plant and Oconee	1/2	10.4± .3
Hartsville	Lake Robinson	H. B. Robinson	1/4	2.1
Tenn: Kingston	Clinch River	Oak Ridge	2/8	2.9
Tex: El Paso	Rio Grande	Los Alamos	1/3	.4
Vt: Vernon	Connecticut River	Vermont Yankee	1/5	.2
Va: Newport News	James River	Surry	*12/20	0
Wash: Northport	Columbia River	Background	2/26	.6
Richland	Columbia River	Hanford	1/3	.5
W. Va: Wheeling	Ohio River	Shippingport	1/8	0
Wisc: Two Creeks	Lake Michigan	Point Beach and Kewaunee	1/15	.3
Victory	Mississippi River	LaCrosse and Prairie Island	1/8	.3
Average				0.8

[a]The minimum detection limit for all samples was 0.20 nCi/liter. All values equal to or less than 0.20 nCi/liter before rounding have been reported as zero
[b]The 2σ error for all samples is 0.2 nCi/liter unless otherwise noted.
*Sample collected early.
NS, no sample.

Table 3. Tritium concentration in precipitation from RAN stations, January-March 1973

Location	Tritium concentration[a] (nCi/liter ±2σ)		
	January	February	March
Ala: Montgomery	0.3	0.0	0.0
Alaska: Anchorage	.0	NS	NS
Colo: Denver	.2	NS	.4
Hawaii: Honolulu	.0	.0	.0
La: New Orleans	.0	.0	.0
N.C: Gastonia	.3	.2	.2
Tex: Austin	.0	.0	.0
Wash: Seattle	.0	.0	.0

[a]The minimum detection limit for these samples was 0.20 nCi/liter. All values equal to or less than 0.20 nCi/liter before rounding have been reported as zero. The 2 σ error for all samples is 0.2 nCi/liter unless otherwise noted.
NS, no sample.

Other coverage in *Radiation Data and Reports:*

Period	Issue
January–March 1972	August 1972
April–June 1972	January 1973
July–September 1972	February 1973
October–December 1972	May 1973

Water Surveillance Programs,[1] January 1973

National Environmental Research Center—
Las Vegas, Environmental Protection Agency

The National Environmental Research Center —Las Vegas (NERC-LV) is responsible for conducting a radiological safety and environmental surveillance program in the offsite area surrounding the Nevada Test Site (NTS) in support of nuclear testing conducted by the U.S. Atomic Energy Commission (AEC). When required, additional surveillance programs are established at locations other than around the

[1] This network is operated under a Memorandum of Understanding (No. AT (26–1)–539) with the Nevada Operations Office, U.S. Atomic Energy Commission, Las Vegas, Nev.

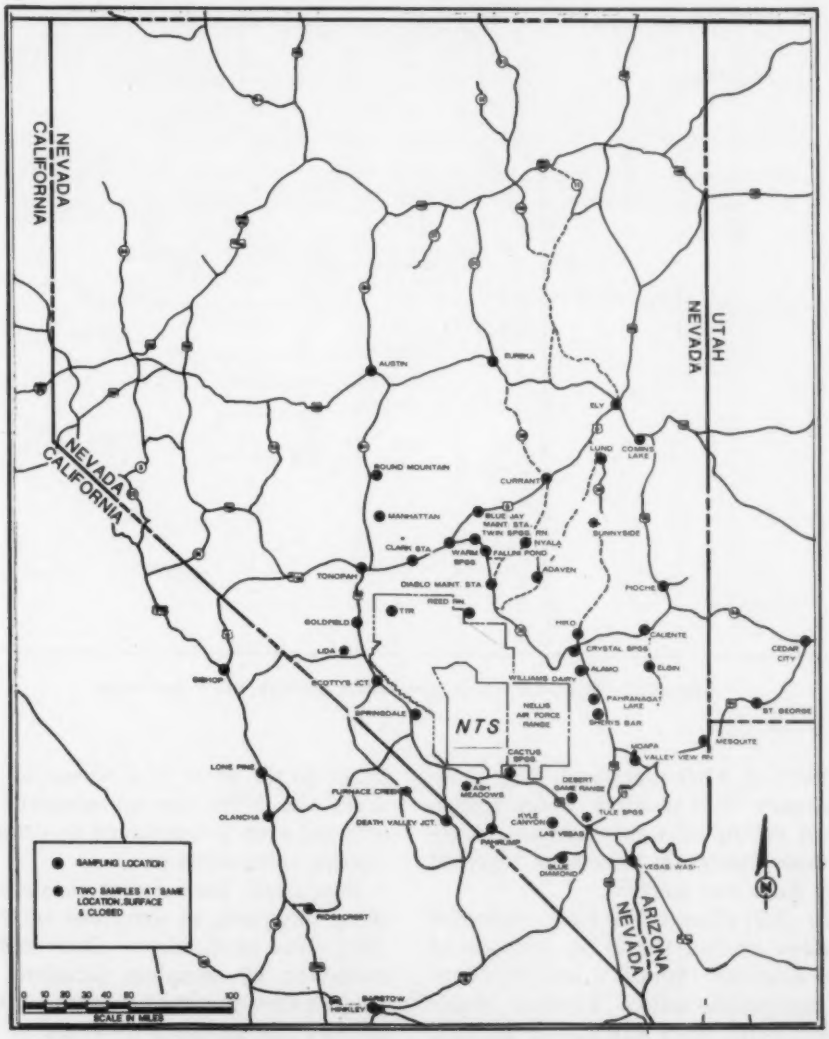

Figure 1. NERC-LV Water Surveillance Network

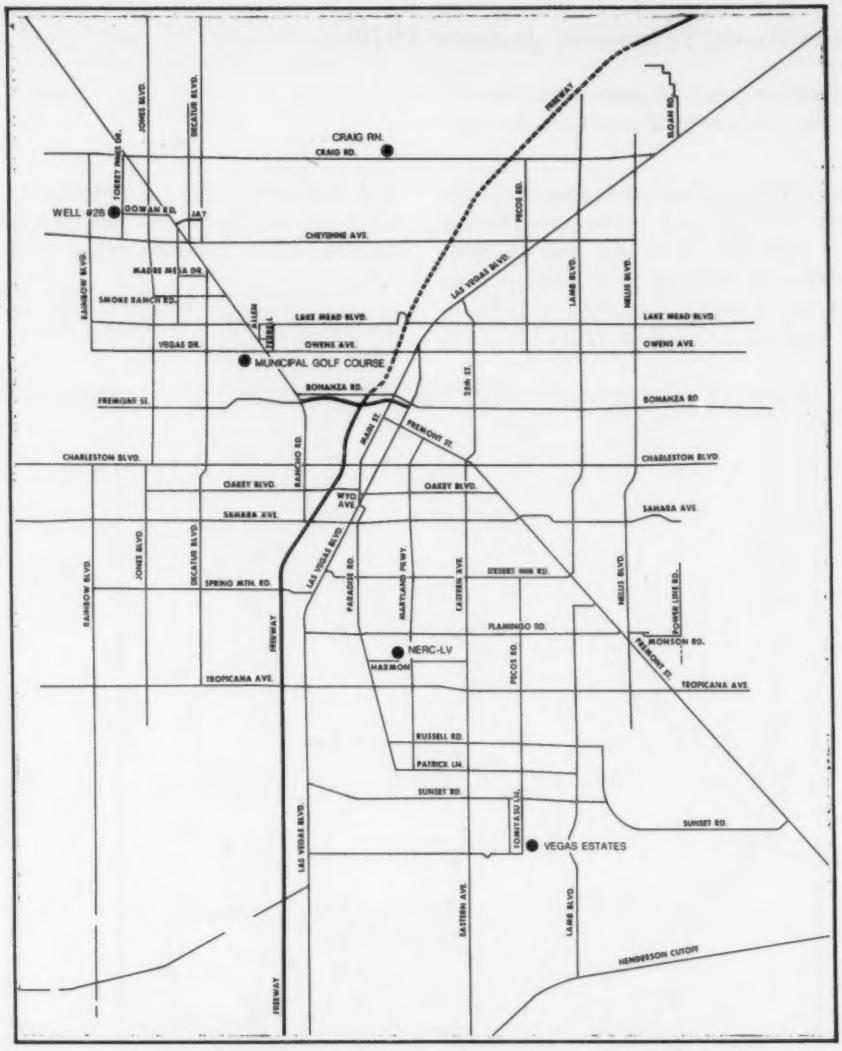

Figure 2. NERC-LV Water Surveillance Network, Las Vegas Valley

NTS in support of AEC operations. Beginning with the January 1972 monthly water report, the analytical results of water samples collected for the above program have been reported in *Radiation Data and Reports.*

The Water Surveillance Network,[1] operated in offsite areas around the NTS, consists of 61 sampling locations (figures 1 and 2) where NERC-LV personnel collect 1-gallon water samples from wells, open and closed springs, lakes, and ponds on a monthly or quarterly basis. In the event of a release of radioactivity from the NTS, special sampling within the affected area is conducted to determine radionuclide concentrations.

Previously, the network consisted of 90 sampling locations, as described in the December 1972 issue of *Radiation Data and Reports.* A reduction of sampling locations was implemented this year to economize operations and yet provide adequate coverage in the event of a release.

Table 1. Analytical procedures

Type of analysis	Analytical equipment	Counting period (minutes)	Analytical procedures	Sample size (liter)	Detection limits (pCi/liter)
Gamma [a]	Gamma spectrometer with a 10- by 10-cm NaI(Tl) crystal with input to 200 channels (0–2 MeV) of 400- channel pulse-height analyzer.	10–40	Radionuclide concentrations quantitated from gamma spectrometer data by computer using an eight element matrix technique.	3.5	Generally 10 pCi/liter for most common fallout radionuclides in a simple spectrum
Tritium	Automatic liquid scintillation counter with output printer.	100	Sample prepared by distillation and counted in scintillation counter.	.005	[b], [c] ≈320
Strountium-89-, strontium-90	Low background, thin-window, gas flow proportional counter with a 5.7-cm-diameter window (80 μg/cm²).	50	Chemical separation by ion exchange. Separated sample counted successively; activity calculated by solution of simultaneous equations.	1.0	[b]Strontium-89 ≈5 [b]Strontium-90 ≈2
Radium-226	Alpha scintillation counter.	30	Chemical separation of radium. Separated sample dissolved and quantitated by radon emanation procedure.	1.5	[b] ≈0.1
Gross alpha,[d] gross beta [d] liter	Low background, thin-window gas flow proportional counter with a 5.7-cm diameter window (80 μg/cm²).	50	Sample evaporated, and residue counted.	.2	[d] alpha ≈2 [b] beta ≈2

[a] On total liquid sample.
[b] The detection limit for a given sample is defined as that concentration which is equal to the 2-sigma counting error.
[c] The detection limit for samples analyzed during February 1972 and thereafter was ≈220 pCi/liter.
[d] On total solids of samples.

Table 2. Water surveillance results, January 1973

Location	Date collected (1973)	Sample type[a]	Radioactivity concentrations[b] (pCi/liter)		
			Gross alpha	Gross beta	Tritium
California:					
Bishop:					
Fish and Game Office	1/3	23	<1.8	<3.3	NA
Death Valley Junction:					
Lila's Cafe	1/4	23	<5.6	7.0±3.8	<230
Furnace Creek:					
Pond	1/4	21	<4.3	7.0±3.7	NA
Visitor Center	1/4	27	<4.3	6.2±3.6	NA
Hinkley:					
Bill Nelson Dairy	1/3	23	12±6.5	4.3±3.5	NA
Lone Pine:					
Forest Service Ranger Station	1/3	23	<2.2	<3.3	NA
Olancha:					
Haiwee Reservoir	1/3	21	8.8±5.0	4.8±3.5	NA
Ridgecrest:					
City Hall	1/3	23	<4.1	<3.4	NA
Nevada:					
Adaven:					
Canfield Ranch	NS				
Alamo:					
Pahranagat Lake	1/8	21	16±7.5	18±4.2	NA
Sheri's Bar	1/8	23	<6.3	<3.6	NA
Williams Dairy	1/8	23	<4.0	11±3.8	NA
Ash Meadows:					
Ash Meadows Lodge	1/9	23	9.8±7.4	14±4.3	<240
Ash Meadows Pond	1/9	21	24±9.2	14±4.2	NA
Austin:					
Nevada National Bank	1/3	27	28±7.3	9.8±3.7	NA
Blue Diamond:					
Post Office	1/8	23	5.2±4.5	<3.5	<240
Blue Jay Highway:					
Maintenance Station	1/11	23	<3.6	<3.5	NA
Cactus Springs:					
Mobil Service Station	1/11	27	<2.4	<3.5	<240
Caliente:					
Agricultural Extension Station	1/10	23	<3.8	<3.3	NA
Clark Station:					
Five Mile Ranch	1/10	27	<2.1	5.7±3.6	NA
Currant:					
Currant Ranch Cafe	NS				
Diablo:					
Highway Maintenance Station	1/10	23	<3.4	7.4±3.6	NA
Reed Ranch	1/10	21	28±11	41±5.6	NA

See footnotes at end of table.

Table 2. Water surveillance results, January 1973—continued

Location	Date collected (1973)	Sample type[a]	Radioactivity concentrations[b] (pCi/liter)		
			Gross alpha	Gross beta	Tritium
Elgin:					
Water Tower	1/10	23	7.9±5.9	6.2±3.5	NA
Ely:					
Chevron Service Station	NS				
Comins Lake	NS				
Eureka:					
Highway Maintenance Station	1/9	24	3.5±3.5	<3.3	NA
Goldfield:					
Chevron Service Station	1/15	23	<2.6	<3.5	NA
Hiko:					
Crystal Springs	1/8	27	5.6±4.2	5.6±3.4	NA
Schofield Dairy	1/8	23	17±7.9	25±4.6	NA
Las Vegas:					
Craig Ranch Golf Course	1/15	23	8.6±4.3	<3.5	<250
Desert Game Range	1/11	23	5.7±3.6	<3.5	<240
Lab II, NERC-LV	1/15	24	<4.9	7.4±3.6	760±270
Lake Mead Vegas Wash	1/15	21	<4.7	11±4.0	640±260
L V Water District Well 28	1/15	23	<3.2	<3.3	<250
Municipal Golf Course	1/15	23	<2.4	3.4±3.3	<250
Tule Springs	1/11	23	3.3±3.0	<3.5	<240
Tule Springs Pond	1/11	21	6.8±3.8	<3.5	NA
Vegas Estates	1/15	23	<4.2	5.3±3.8	<250
Lida:					
Lida Livestock Company	1/15	27	<2.4	<3.4	NA
Pond at storage tank	1/15	21	5.3±3.7	<3.4	NA
Lund:					
Gardner Grocery	1/11	23	<3.0	<3.3	NA
Manhattan:					
Country store	1/16	23	18±7.2	4.6±3.6	NA
Mesquite:					
Hughes Bros. Dairy	1/8	23	<5.2	6.7±3.8	NA
Moapa:					
Pedersen Valley View Ranch	1/8	27	<5.1	9.9±3.8	NA
Mt. Charleston:					
Kyle Canyon Fire Station	1/11	27	<3.1	<3.5	<240
Nyala:					
Sharp's Ranch	1/16	23	<2.5	<3.4	NA
Pahrump:					
Texaco Service Station	1/8	23	<2.9	<3.5	NA
Pioche:					
County Courthouse	1/9	24	<3.0	3.4±3.3	NA
Round Mountain:					
Mobil Service Station	1/16	24	<2.1	<3.4	NA
Scotty's Junction:					
Chevron Service Station	1/15	23	<4.2	8.6±3.9	<240
Springdale:					
Pond	1/10	21	6.8±5.8	4.2±3.7	NA
Sunnyside:					
Adam McGill Reservoir	1/11	21	10±5.0	<3.5	NA
Wildlife Management Headquarters	1/11	27	<2.7	<3.5	NA
Tonopah:					
Jerry's Chevron Station	1/17	23	3.1±2.9	5.3±3.5	NA
Tonopah Test Range CP–1	1/17	23	5.5±4.2	5.8±3.6	NA
Warm Springs:					
Fallini's Pond	NS				
Service Station and Cafe	NS				
Twin Springs Ranch	1/11	23	5.6±4.7	11±4.0	NA
Utah:					
Cedar City:					
M. D. Baldwin residence	1/9	24	<1.9	<3.5	NA
St. George:					
R. Cox Dairy	1/8	24	3.5±2.4	<3.5	NA

[a]21—Pond, lake, reservoir, stock tank, stock pond.
22—Stream, river, creek.
23—Well
24—Multiple supply mixed (a water sample consisting of mixed or multiple sources of water such as well and spring).
27—Spring.
[b]Two-sigma counting error provided when available.
NA, not analyzed.
NS, no sample.

Analytical procedures

All samples are analyzed by gamma spectroscopy and counted for gross alpha and gross beta radioactivity. In addition, samples from 14 locations west, south, and southeast of NTS are routinely analyzed for tritium. For the purpose of identifying the source of gross radioactivity in all network samples and comparing sample concentrations with both the AEC concentration guides and the PHS Drinking Water Standards, selected samples from each sampling location are given special analyses at least once each year. For surface water samples, the spe-

cial analyses include strontium-89, strontium-90, plutonium-238, plutonium-239, uranium, and radium-226. For drinking water samples, the analyses include strontium-89, strontium-90, uranium, and radium-226. Additional special analyses are performed on selected samples when indicated by gross alpha or gross beta concentrations, and when radioactivity related to AEC operations is detected by gamma spectroscopy.

Table 1 lists the general analytical procedures and detection limits, as described by Johns (*1*) and Lem and Snelling (*2*). For gamma spectroscopy analysis, the samples are placed in 3.5-liter inverted-well Marinelli beakers. All routine samples are counted 40 minutes. Special samples collected following known releases of radioactivity are normally counted for 20 minutes, but this may vary from 10 to 40 minutes, depending upon radionuclide concentrations and total sample workload. The radioactivity concentration of each of the detected radionuclides at time of count is calculated and extrapolated to time of collection.

Results

The routine analytical results of all water samples collected in January 1973 by the NERC-LV water surveillance program are listed in table 2. No gamma-emitting fission products were identified by gamma spectrometry in any of the samples collected in January 1973. The analytical results for samples selected for special analyses will be reported at a later date.

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(*2*) LEM, P. N. and R. N. SNELLING. Southwestern Radiological Health Laboratory data analysis and procedures manual, SWRHL–21. Southwestern Radiological Health Laboratory, Las Vegas, Nev. (March 1971).

SECTION III. AIR AND DEPOSITION

Radioactivity in Airborne Particulates and Precipitation

Continuous surveillance of radioactivity in air and precipitation provides one of the earliest indications of changes in environmental fission product radioactivity. To date, this surveillance has been confined chiefly to gross beta radioanalysis. Although such data are insufficient to assess total human radiation exposure from fallout, they can be used to determine when to modify monitoring in other phases of the environment.

Surveillance data from a number of programs are published monthly and summarized periodically to show current and long-range trends of atmospheric radioactivity in the Western Hemisphere. These include data from activities of the Environmental Protection Agency, the Canadian Department of National Health and Welfare, Pan American Health Organization and the California State Department of Public Health.

In addition to those programs presented in this issue, the following programs were previously covered in *Radiation Data and Reports.*

Network	Period	Issue
Fallout in the United States and other areas, *HASL*	January–December 1970	December 1971
Mexican air monitoring program	September–December 1972	June 1973
Plutonium in airborne particulates	October–December 1972	June 1973
Surface air sampling program, 80th Meridian Network, HASL	1970	May 1973

1. Radiation Alert Network March 1973

Quality Assurance and Environmental Monitoring Laboratory, National Environmental Research Center—Research Triangle Park, Environmental Protection Agency

Surveillance of atmospheric radioactivity in the United States is conducted by the Radiation Alert Network (RAN) which regularly gathers samples at 68 locations distributed throughout the country (figure 1). Most of the stations are operated by State health department personnel.

The station operators perform "field estimates" on the airborne particulate samples at 5 hours after collection, when most of the radon daughter products have decayed, and at 29 hours after collection, when most of the thoron daughter products have decayed. They also perform field estimates on dried precipitation samples and report all results to appropriate Environmental Protection Agency officials by mail or telephone depending on levels found. A compilation of the daily field estimates is available upon request from the Quality Assurance and Environmental Monitoring Laboratory, NERC-RTP, EPA, Research Triangle Park, N.C. 27711. A detailed description of the sampling and analytical procedures was presented in the March 1968 issue of *Radiological Health Data and Reports.*

Table 1 presents the monthly average gross beta radioactivity in surface air particulates and deposition by precipitation, as measured by the field estimate technique, during March 1973.

Figure 1. Radiation Alert Network sampling stations

Table 1. Gross beta radioactivity in surface air and precipitation, March 1973

Station location		Number of samples	Gross beta radioactivity (5-hour field estimate) (pCi/m³)			Number of samples	Total depth (mm)	Precipitation		
								Field estimation of deposition		
			Maximum	Minimum	Average [a]			Number of samples	Depth (mm)	Total deposition (nCi/m²)
Ala:	Montgomery	22	2	0	1	5	122	5	122	13
Alaska:	Anchorage	2	0	0	0	0				
	Attu Island	31	0	0	0	0				
	Fairbanks	0				0				
	Juneau	0				0				
	Nome	0				0				
	Point Barrow	0				0				
Ariz:	Phoenix	19	7	0	2	0				
Ark:	Little Rock	0				0				
Calif:	Berkeley	22	0	0	0	6	50	6	50	0
	Los Angeles	21	1	0	0	0				
C.Z:	Ancon	18	0	0	0	0				
Colo:	Denver	22	3	0	1	4	32	[b]		
Conn:	Hartford	22	0	0	0	7	84	7	84	0
Del:	Dover	22	0	0	0	0				
D.C:	Washington	22	1	0	0	0				
Fla:	Jacksonville	19	1	0	0	6	132	6	132	2
	Miami	8	0	0	0	3	36	3	36	0
Ga:	Atlanta	12	1	0	0	0				
Guam:	Agana	0				0				
Hawaii:	Honolulu	21	0	0	0	6	48	[b]		
Idaho:	Boise	22	2	0	1	2	21	2	21	4
Ill:	Springfield	15	1	0	0	0				
Ind:	Indianapolis	0				0				
Iowa:	Iowa City	21	3	0	1	5	89	5	89	9
Kans:	Topeka	22	2	0	1	11	175	11	175	5
Ky:	Frankfort	14	1	0	1	0				
La:	New Orleans	19	1	0	0	10	277	[b]		
Maine:	Augusta	18	0	0	0	5	35	5	35	0
Md:	Baltimore	21	2	0	0	7	58	7	58	0
Mass:	Lawrence	22	1	0	0	5	60	5	60	0
	Winchester	20	2	0	0	6	63	6	63	0
Mich:	Lansing	21	0	0	0	0				
Minn:	Minneapolis	22	1	0	0	6	48	6	48	9
Miss:	Jackson	11	0	0	0	7	177	7	177	0
Mo:	Jefferson City	22	1	0	0	0				
Mont:	Helena	17	2	0	1	0				
Nebr:	Lincoln	22	3	0	1	4	84	4	84	10
Nev:	Las Vegas	22	4	0	1	0				
N.H:	Concord	0				0				
N.J:	Trenton	21	1	0	0	7	104	7	104	2
N. Mex:	Santa Fe	18	1	0	1	6	36	6	36	0
N.Y:	Albany	18	1	0	1	0				
	Buffalo	22	1	0	0	0				
	New York City	0				0				
N.C:	Gastonia	22	6	0	1	6	48			
N. Dak:	Bismarck	22	4	0	1	4	14	4	14	3
Ohio:	Cincinnati	0				0				
	Columbus	2	0	0	0	0				
	Painesville	21	0	0	0	7	75	7	75	11
Okla:	Oklahoma City	0				0				
Oreg:	Portland	22	0	0	0	10	71	10	71	3
Pa:	Harrisburg	19	1	0	0	0				
P.R:	San Juan	0				0				
R.I:	Providence	20	1	0	0	0				
S.C:	Columbia	10	1	0	0	7	162	7	162	0
S. Dak:	Pierre	17	4	1	2	0				
Tenn:	Nashville	22	1	0	0	12	222	12	222	0
Tex:	Austin	20	5	1	2	2	25	[b]		
	El Paso	16	5	1	1	0				
Utah:	Salt Lake City	31	2	0	0	9	47	9	47	3
Vt:	Barre	20	1	0	0	6	53	6	53	3
Va:	Richmond	16	0	0	0	6	60	6	60	3
Wash:	Seattle	9	0	0	0	7	63	[b]		
	Spokane	19	2	0	1	0				
W. Va:	Charleston	22	2	0	1	11	82	11	82	7
Wisc:	Madison	22	1	0	0	6	122	6	122	3
Wyo:	Cheyenne	8	2	0	1	0				
Network summary		1,053	7	0	1	211	103	7	85	3

[a] The monthly average is calculated by weighting the field estimates of individual air samples with length of sampling period.
[b] This station is part of the tritium surveillance system. No gross beta measurements are done.

2. Canadian Air and Precipitation Monitoring Program,[1] March 1973

Radiation Protection Division
Department of National Health and Welfare

The Radiation Protection Division of the Canadian Department of National Health and Welfare monitors surface air and precipitation in connection with its Radioactive Fallout Study Program. Twenty-four collection stations are located at airports (figure 2), where the sampling equipment is operated by personnel from the Meteorological Services Branch of the Department of Transport. Detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in reports of the Department of National Health and Welfare (*1–5*).

A summary of the sampling procedures and methods of analysis was presented in the May 1969 issue of *Radiological Health Data and Reports*.

[1] Prepared from information and data obtained from the Canadian Department of National Health and Welfare, Ottawa, Canada.

Surface air and precipitation data for March 1973 are presented in table 2.

Table 2. Canadian gross beta radioactivity in surface air and precipitation, March 1973

Station	Number of samples	Air surveillance gross beta radioactivity (pCi/m³)			Precipitation measurements	
		Maximum	Minimum	Average	Average concentration (pCi/liter)	Total deposition (nCi/m²)
Calgary	4	0.02	<0.01	0.01	8	0.1
Coral Harbour	4	.03	.01	.03	13	.2
Edmonton	4	.03	.02	.02	28	.3
Ft. Churchill	4	.03	.02	.03	25	.2
Fredericton	4	.02	.01	.02	7	.6
Goose Bay	4	.02	.01	.02	5	.2
Halifax	4	.03	.01	.02	6	.8
Inuvik	4	.04	.03	.03	38	.4
Montreal	4	.02	.01	.01	7	.6
Moosonee	4	.04	.02	.03	13	.2
Ottawa	4	.02	.01	.02	9	1.0
Quebec	4	.02	.01	.02	11	1.1
Regina	4	.02	.02	.02	39	.5
Resolute	4	.05	.03	.04	77	.1
St. John's, Nfld	1	.01	.01	.01	3	.2
Saskatoon	4	.02	.02	.02	79	.3
Sault Ste. Marie	4	.03	.02	.02	NS	NS
Thunder Bay	4	.02	.01	.02	11	.7
Toronto	3	.01	.01	.01	6	.9
Vancover	4	.01	.01	.01	12	.8
Whitehorse	4	.03	<.01	.02	20	.1
Windsor	4	.02	.01	.01	8	1.0
Winnipeg	4	.02	.02	.02	18	.2
Yellowknife	4	.03	.01	.02	7	.2
Network summary	92	0.05	<0.01	0.02	20	0.5

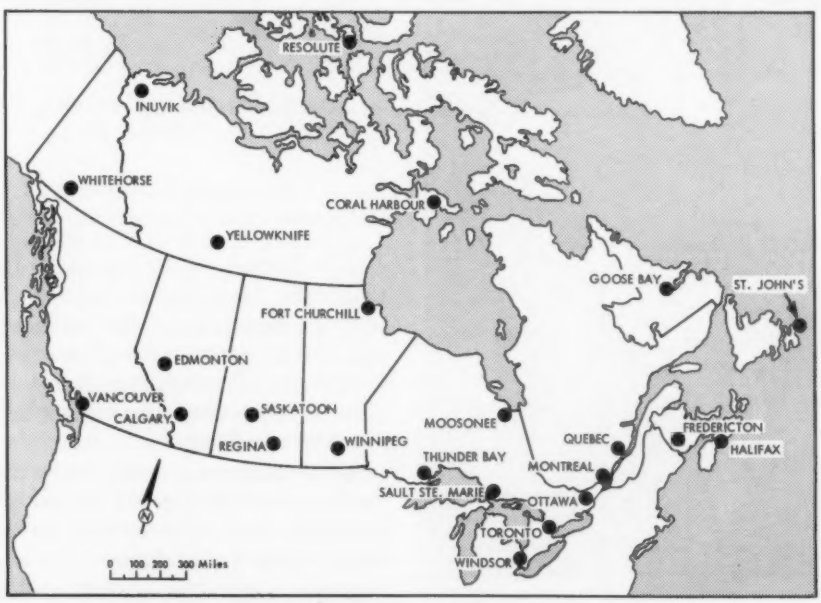

Figure 2. Canadian air and precipitation monitoring program

3. Pan American Air Sampling Program March 1973

Pan American Health Organization and U.S. Environmental Protection Agency

Gross beta radioactivity in air is monitored by countries in the Americas under the auspices of the collaborative program developed by the Pan American Health Organization (PAHO) and the Environmental Protection Agency (EPA) to assist PAHO-member countries in developing radiological health programs.

The air sampling station locations are shown in figure 3. Analytical techniques were described in the March 1968 issue of *Radiological Health Data and Reports*. The March 1973 air monitoring results from the participating countries are given in table 3.

Table 3. Summary of gross beta radioactivity in Pan American surface air, March 1973

Station location		Number of samples	Gross beta radioactivity (pCi/m³)		
			Maximum	Minimum	Average[a]
Argentina:	Buenos Aires	0			
Bolivia:	La Paz	18	0.01	0.00	0.00
Chile:	Santiago	29	.03	.01	.02
Colombia:	Bogota	21	.02	.00	.01
Ecuador:	Cuenca	8	.02	.00	.00
	Guayaquil	18	.02	.00	.01
	Quito	13	.01	.00	.00
Guyana:	Georgetown	10	.01	.00	.00
Jamaica:	Kingston	0			
Peru:	Lima	0			
Venezuela:	Caracas	11	.02	.00	.01
West Indies:	Trinidad	16	.04	.00	.02
Pan American summary		144	0.04	0.00	0.01

[a]The monthly average is calculated by weighting the individual samples with length of sampling period. Values less than 0.005 pCi/m³ are reported and used in averaging as 0.00 pCi/m³.

Figure 3. Pan American Air Sampling Program stations

4. California Air Sampling Program March 1973

Bureau of Radiological Health
California State Department of Public Health

The Bureau of Radiological Health of the California State Department of Public Health with the assistance of several cooperating agencies and organizations operates a surveillance system for determining radioactivity in airborne particulates. The air sampling locations are shown in figure 4.

All air samples are sent to the Sanitation and Radiation Laboratory of the State Department of Public Health where they are analyzed for their radioactive content.

Airborne particles are collected by a continuous sampling of air filtered through a 47 milli-

Figure 4. California air sampling program stations

meter membrane filter, 0.8 micron pore size, using a Gast air pump of about 2 cubic feet per minute capacity, or 81.5 cubic meters per day. Air volumes are measured with a direct reading gas meter. Filters are replaced every 24 hours except on holidays and weekends. The filters are analyzed for gross alpha and beta radioactivity 72 hours after the end of the collection period. The daily samples are then composited into a monthly sample for gamma spectroscopy and an analysis for strontium-89 and strontium-90. Table 4 presents the monthly gross beta radioactivity in air for March 1973. The monthly sample results are presented quarterly.

Table 4. Gross beta radioactivity in California air March 1973

Station location	Number of samples	Gross beta radioactivity (pCi/m³)		
		Maximum	Minimum	Average
Bakersfield	29	0.33	0.00	0.10
Barstow	31	.28	.00	.10
Berkeley	29	.11	.00	.03
El Centro	28	.22	.00	.06
Eureka	30	.14	.00	.04
Fresno	30	.29	.01	.05
Los Angeles	30	.17	.00	.05
Redding	30	.18	.00	.04
Sacramento	30	.09	.00	.04
Salinas	28	.38	.00	.11
San Bernardino	27	.20	.00	.05
San Diego	26	.09	.00	.04
San Luis Obispo	30	.18	.00	.05
Santa Rosa	31	.15	.00	.03
Summary	409	0.38	0.00	0.06

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(5) BOOTH, A. H. The calculation of permissible levels of fallout in air and water and their use in assessing the significance of 1961 levels in Canada, RPD–21. Department of National Health and Welfare, Ottawa, Canada (August 1962).

Air Surveillance Network, March 1973

National Environmental Research Center—Las Vegas,[1] Environmental Protection Agency

The Air Surveillance Network (ASN), operated by the National Environmental Research Center-Las Vegas (NERC-LV), consists of 49 active and 73 standby sampling stations located in 21 western States (figures 1 and 2). The network is operated in support of nuclear testing sponsored by the Atomic Energy Commission (AEC) at the Nevada Test Site (NTS), by the Space Nuclear Systems Office at the Nuclear Rocket Development Station (which lies within the NTS), and by the AEC at any other designated testing sites.[2]

The stations are operated by State health department personnel and by private individuals on a contract basis. All active stations are operated continuously with filters being exchanged over periods generally ranging from 24 to 72 hours. All samples are mailed to the NERC-LV unless special retrieval is arranged at selected locations in response to known releases of radioactivity from the NTS. A complete description of sampling and analytical procedures was presented in the February 1972 issue of *Radiation Data and Reports.*

Results

Table 1 presents the monthly average gross beta concentrations in air for each of the network stations. The highest gross beta concentration within the network was less than 0.2 pCi/m^3 at Death Valley Junction, Calif.; Beatty,

[1] Formerly the Western Environmental Research Laboratory.

[2] The ASN is operated under a Memorandum of Understanding (No. AT(26–1)–539) with the Nevada Operations Office, U.S. Atomic Energy Commission.

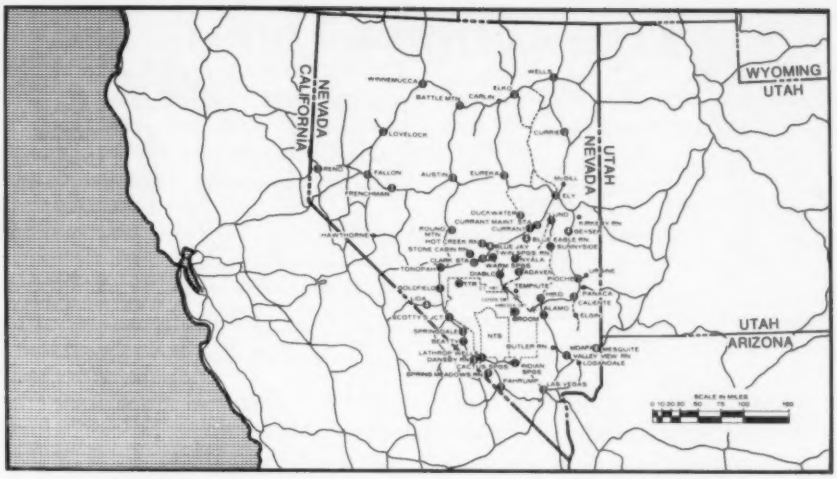

Figure 1. NERC-LV Air Surveillance Network stations in Nevada

Table 1. Summary of gross beta radioactivity concentrations in air, March 1973

Location		Number of samples	Concentration (pCi/m³)		
			Maximum	Minimum	Average [a]
Ariz:	Kingman	31	<0.1	<0.1	<0.1
	Seligman	31	<.1	<.1	<.1
Calif:	Baker	27	.1	<.1	.1
	Barstow	31	<.1	<.1	<.1
	Bishop	31	<.1	<.1	<.1
	Death Valley Junction	29	<.2	<.1	<.1
	Furnace Creek	31	<.1	<.1	<.1
	Lone Pine	24	<.1	<.1	<.1
	Needles	22	<.1	<.1	<.1
	Ridgecrest	31	<.1	<.1	<.1
	Shoshone	31	.1	<.1	<.1
Nev:	Alamo	31	.1	<.1	<.1
	Austin	23	.1	<.1	<.1
	Beatty	31	<.2	<.1	<.1
	Blue Eagle Ranch (Currant)	29	<.2	<.1	<.1
	Blue Jay	31	.1	<.1	<.1
	Caliente	30	<.1	<.1	<.1
	Currant Ranch	31	<.1	<.1	<.1
	Diablo	31	<.1	<.1	<.1
	Duckwater	28	<.1	<.1	<.1
	Ely	31	<.1	<.1	<.1
	Eureka	31	<.1	<.1	<.1
	Fallini's Twin Springs Ranch	31	<.1	<.1	<.1
	Geyser Maintenance Station	31	<.1	<.1	<.1
	Goldfield	31	<.2	<.1	<.1
	Groom Lake	21	.1	<.1	<.1
	Hiko	31	<.1	<.1	<.1
	Indian Springs	31	<.1	<.1	<.1
	Las Vegas	22	.1	<.1	<.1
	Lathrop Wells	30	<.1	<.1	<.1
	Lida	31	<.1	<.1	<.1
	Lund	31	<.1	<.1	<.1
	Mesquite	31	<.1	<.1	<.1
	Nyala	31	<.1	<.1	<.1
	Pahrump	31	<.1	<.1	<.1
	Pioche	30	<.1	<.1	<.1
	Round Mountain	31	<.1	<.1	<.1
	Scotty's Junction	30	.1	<.1	<.1
	Stone Cabin Ranch	30	<.1	<.1	<.1
	Sunnyside	30	<.2	<.1	<.1
	Tonopah	31	<.1	<.1	<.1
	Tonopah Test Range	24	<.1	<.1	<.1
	Warm Springs	29	<.1	<.1	<.1
	Warm Springs Ranch	31	<.1	<.1	<.1
Utah:	Cedar City	26	<.1	<.1	<.1
	Delta	31	<.2	<.1	<.1
	Garrison	31	<.1	<.1	<.1
	Milford	31	<.1	<.1	<.1
	St. George	31	<.1	<.1	<.1

[a] Individual values less than the minimum detectable concentration (MDC) are set equal to the MDC for averaging. A monthly average less than the minimum reportable value of 0.1 pCi/m³ is reported as <0.1.

Figure 2. NERC-LV Air Surveillance Network stations outside Nevada

Goldfield, Blue Eagle Ranch, and Sunnyside, Nev.; and Delta, Utah. The minimum reporting concentration for gross beta is 0.1 pCi/m³. For averaging purposes, individual concentrations which are below the minimum detectable concentration (0.06 pCi/m³) are assumed to be equal to the minimum detectable concentration. Averages less than the minimum reporting level (0.1 pCi/m³) are reported as <0.1 pCi/m³. No radionuclides were identified by gamma spectrometry on any filters or charcoal cartridges during March.

Complete copies of this summary and listings of the daily gross beta and gamma spectrometry results are distributed to EPA regional offices and appropriate State agencies. Additional copies of the daily results may be obtained from the NERC-LV upon written request.

SECTION IV. OTHER DATA

This section presents results from routine sampling of biological materials and other media not reported in the previous sections. Included here are such data as those obtained from human bone sampling, Alaskan surveillance, and environmental monitoring around nuclear facilities.

Environmental Levels of Radioactivity at Atomic Energy Commission Installations

The U.S. Atomic Energy Commission (AEC) receives from its contractors annual reports on the environmental levels of radioactivity in the vicinity of major Commission installations. The reports include data from routine monitoring programs where operations are of such a nature that plant environmental surveys are required.

Releases of radioactive materials from AEC installations are governed by radiation standards set forth by AEC's Division of Operational Safety in directives published in the "AEC Manual." [1]

A summary of the environmental radioactivity data follows for the Paducah Plant.

[1] Title 10, Code to Federal Regulations, Part 20, "Standards for Protection Against Radiation" contains essentially the standards published in Chapter 0524 of the AEC Manual.

1. Paducah Plant [2] January-December 1971

Union Carbide Corporation
Paducah, Ky.

The Paducah Gaseous Diffusion Plant (PGDP) is located in McCracken County, Kentucky, about 4 miles south of the Ohio River and 20 miles east of the confluence of the Ohio and Mississippi Rivers. The plant is an AEC-owned, contractor-operated uranium enrichment cascade with associated uranium hexafluoride (UF_6) manufacturing plant and extensive support facilities. The Paducah processing facility now consists of 1,812 diffusion stages housed in five buildings with a total ground coverage of about 74 acres. Including support facilities, the plant has a total complement of about 30 permanent buildings.

Except for the large raw water treatment plant, all buildings are within a 750-acre fenced area. A buffer area of at least 1,500 feet in depth exists on all sides of the fenced area. Beyond the AEC-owned buffer is an extensive wildlife management area deeded to the Commonwealth of Kentucky. There are no habitations within 3,000 feet of any of the process buildings. The nearest incorporated towns are Metropolis, Ill., located 5 miles to the northeast and LaCenter, Ky., located 11 miles west southwest. Paducah, Ky., a city of 35,000, is located 12 miles east of the plant.

The primary plant, the diffusion cascade, contains a physical process in which UF_6 is fed into the system, pumped through the diffusion stages and eventually is removed, still as UF_6. The product is enriched in the fissionable uranium-235 isotope and the "tails" are withdrawn at the bottom as depleted UF_6. The process pumps require electric power, lubrication, and air for cooling. The compressed gases are cooled by a heat exchange fluid, which is in turn cooled by recirculating cooling water.

The basic inputs to the feed manufacturing plant are hydrogen, anhydrous hydrogen fluo-

[2] Summarized from "Environmental Monitoring at Major U.S. Atomic Energy Commission Sites, Paducah Plant, Calendar Year 1971."

ride (HF), and uranium oxide (UO_3). The product is uranium hexafluoride (UF_6). Theoretically, 1,000 tons of HF are required to convert 2,000 tons of uranium from the oxide to UF_6.

Some of the depleted UF_6 from the cascade is reacted with hydrogen to recover HF and to convert the volatile UF_6 to the more easily stored UF_4. In the same facility, the Metals Plant, some of the UF_4 is reduced to metal by reaction with magnesium. The reaction results in the largest volume solid waste product of the plant processes, a magnesium fluoride slag.

Air monitoring

Continuously operating air sampling stations are established on electric power poles at four locations on the perimeter fence and at five locations approximately 1 mile from the plant site. Each sampling station consists of a metal housing sheltering a 2-inch membrane filter holder and containing (as the air flows) a flow meter, a gas scrubber, flow throttling valve, and an air pump. Air flow through the system is adjusted to 0.3 cfm (86 cubic meters per week). The membrane filter is removed each week for long-lived alpha and beta radioactivity determinations.

The gas bubbler is filled to about a 6-inch depth with glass beads to disperse the air in the scrubbing solution of about 1 liter of 0.025 normal sodium hydroxide. This collection technique is essentially 100 percent efficient for HF collection in the parts per billion range. The fluoride content is determined by the specific ion electrode method. Results of the environmental air sampling program are shown in table 1.

Alpha radioactivity attributed to uranium from the plant averaged less than the minimum detectable level at the outer edge of the buffer zone. The samplers on the north and east perimeter fences, which are nearest the Feed Plant and the Metals Plant, collected detectable amounts. Beta radioactivity levels at all stations and in all samples were far below the applicable concentration guide.

All gas scrubber samples collected offsite over weeklong periods and analyzed for fluorides were within the Kentucky ambient air standard. The average results were about 20 percent of the standard.

Water monitoring

Water samples are collected continuously in the Big Bayou and in the Little Bayou (essentially a drainage ditch traversing AEC and TVA property). Grab samples are taken each month from several locations in the Ohio River, at the mouth of the Bayous, and from two test wells. The effluent from the sewage disposal plant is sampled for weekly determinations of suspended solids and BOD.[2] Weekly grab samples for BOD determination also are taken upstream and downstream from the sewage plant outfall.

[2] BOD, biological oxygen demand.

Table 1. Environmental air sampling results, Paducah Plant, January-December 1971

Sampling point [a]	Number of samples	Alpha radioactivity concentration (fCi/m³)			Beta radioactivity concentration (pCi/m³)		
		Maximum	Minimum	Average	Maximum	Minimum	Average
At plant perimeter fence:							
North	52	150	20	30	17	<0.1	<2.8
East	52	470	20	40	4.2	<.1	<.7
South	52	50	<20	<20	2.9	<.1	<.4
West	52	70	<20	<20	2.0	<.1	<.5
1 mile outside plant perimeter fence:							
North	52	80	<20	<20	1.0	<.1	<.4
East	52	90	<20	<20	.7	<.1	<.3
Southeast	52	40	<20	<20	.9	<.1	<.3
South	52	80	<20	<20	.7	<.1	<.2
West	52	80	<20	<20	.8	<.1	<.3

[a] See figure 1.

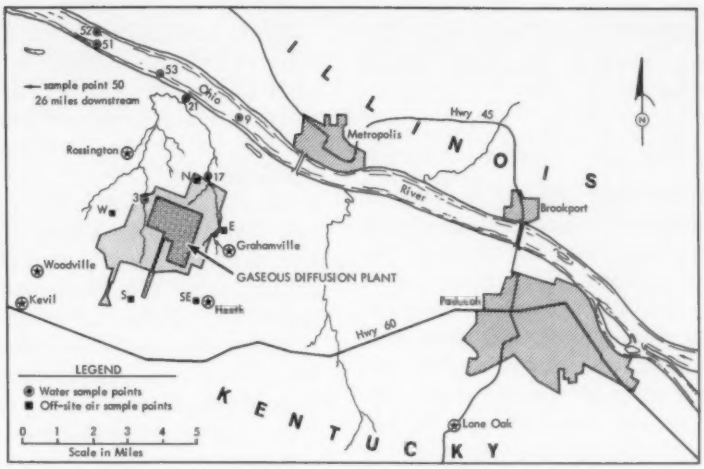

Figure 1. Sampling locations, Paducah Gaseous Diffusion Plant

The extensive water sampling and analyses showed no increase in concentrations of the parameters of interest in either the Ohio River or in ground water (table 2). The concentration of hexavalent chromium at the mouth of the combined creeks was slightly in excess of the Ohio River Valley Water Sanitation Commission (ORSANCO) 70–1 discharge standard of 0.05 mg/liter. The concentrations of uranium and beta radioactivity in the Big Bayou and at the mouth of the creek were well within the ORSANCO and AEC limits. The results of

Table 2. Uranium and beta emitter concentrations in environmental water samples, Paducah Plant, January-December 1971

Sampling point[a]	Number of samples	Uranium (mg/liter)					Beta (pCi/liter)				
		Maximum	Minimum	Average	Standard	Percent of standard	Maximum	Minimum	Average	Standard	Percent of standard
Ohio River:											
9	12	0.009	0.001	0.004	[b] 0.009	44	54	0.0	10	[b] 1,000	1
50, 51, 52, and 53[c]	12	.015	.001	.004	[b] .009	44	72	.0	10	[b] 1,000	1
Big Bayou[d]											
1	12	.011	.001	.003	NA		250	.0	43	NA	
3	52	.170	.001	.022	NA				94	NA	
Mouth of creek:											
21	12	.029	.001	.008	60	.01	610	.0	92	[e] 20,000	.5
Little Bayou[f]											
17	52	11.5	.017	.58	NA		8,600	225	1,700	NA	
Ground water:											
11	12	.006	.001	.002	NA		350	.0	36	NA	
12	12	.006	.001	.002	NA		170	.0	25	NA	

[a] See figure 1.
[b] Kentucky Water Pollution Control Commission regulation WP–4–1.
[c] 50–53, composites.
[d] Unclassified.
[e] Ohio River Valley Sanitation Commission Pollution Control Standard 70–1 (standard for thorium–234).
[f] Unclassified stream on government property.
NA, no analysis.

analyses of the effluent from the sewage disposal plant reflect favorable operating conditions of the secondary treatment.

Soil, flora, and fauna

A set of soil samples was collected from near each of the air sampling stations. Plugs of soil 3½ inches in diameter were removed from the ground down to a uniform depth of 4 inches, dried, pulverized, and blended before analysis. Duplicate aliquots were spiked with uranium-233 and the uranium was quantitatively removed and analyzed by mass spectrometry. The results (table 3) ranged from 0.9 ppm to 2.2 ppm at one of the 1-mile stations and from 3.6 to 24.0 ppm at the perimeter fence. None of these concentrations would be expected to have a significant impact on the environment.

Table 3. Perimeter and offsite concentrations of uranium in soil, Paducah Plant, January-December 1971

Sampling point[a]	Concentation (μg/g dry weight)	Location	Concentration (μg/g dry weight)
At plant perimeter fence:		Offsite:	
North	11.0	North	2.2
East	24.0	East	1.6
South	3.6	South	.9
West	3.9	Southeast	1.1
		West	1.4
Background sample taken 12 miles from plant	.9		

[a]See figure 1.

Grass samples were taken at each of the 1-mile and 5-mile collection stations and were analyzed for fluorides (table 4). The results of the analyses at these stations were all less than 51 percent of the Kentucky fluoride-in-grass standard.

Leaves and grass in the vicinity of the Paducah Plant were examined for possible fumigation damage. None typical of fluorides was observed except for occasional marginal and trip necrosis of broad leaf grass on AEC property.

The area around the plant is in the west Kentucky wildlife management area and supports thriving populations of deer, rabbit, quail, and other wildlife. According to wildlife area management, game taken and checked through the control station appears to have been healthy and no abnormalities were found in a number of rabbits submitted to a State laboratory for examination.

Summary

Air, water, soil, and grass in the vicinity of the Paducah Gaseous Diffusion Plant were continuously or periodically sampled during 1971 at the locations shown on figure 1. Analyses for materials known to be in plant effluents were made to provide effluent control information and to determine compliance with applicable air and water quality standards.

Table 4. Fluoride-in-grass determinations, Paducah Plant, January-December 1971

Sampling point [a]	Number of samples	μg F per gram of dry grass				
		Maximum	Minimum	Average	Standard[b]	Percent of standard
At plant perimeter fence:						
North	6	329	24	150	NA	
East	6	84	17	71	NA	
South	6	43	5.8	24	NA	
West	6	38	4.2	27	NA	
1 mile outside plant perimeter fence:						
North	6	74	.4	20	40	50
Northeast	6	14	5	9.1	40	23
East	6	14	.4	9.2	40	23
East Southeast	6	20	5.0	13	40	32
Southeast	6	15	4.8	11	40	27
South	6	16	4.0	11	40	27
West	6	11	3.2	6.7	40	17
Northwest	6	25	4.2	14	40	35
5 miles outside perimeter fence:						
Northeast	6	12	4.4	8.2	40	20
Southeast	6	12	1.8	5.7	40	14
Southwest	6	11	6.4	9.6	40	24
Northwest	6	15	3.2	9.1	40	23

[a] See figure 1.
[b] Kentucky APCC regulation requires average concentration of F in or on forage not to exceed 40 ppm (μg/g) over growing season (Kentucky APCC–9). Not applicable to onsite perimeter sample point locations.

The air analyses for radioactivity indicate concentrations at all offsite sampling stations averaged less than 1 percent of the applicable AEC standards.[1] Air and grass offsite analyses for fluorides met the Kentucky air quality requirements (*1*).

A set of soil samples collected to provide historical background data was analyzed for uranium. The results ranged from 0.9 ppm to 2.2 ppm at one of the 1-mile stations and from 3.6 ppm to 24.0 ppm at the perimeter fence monitoring stations. None of these concentrations would be expected to have a significant impact on the environment.

There was no detectable change in chemical, physical, or radioactive characteristics of either the Ohio River or ground water attributable to Paducah Gaseous Diffusion Plant operations. The results of water sample analyses of the Ohio River show the chromium and fluoride concentrations were in compliance with the requirements of the applicable Kentucky regulations (*2*). The concentration of hexavalent chromium at the mouth of the combined Big and Little Bayous is slightly in excess of the ORSANCO (*3*) discharge standard of 0.05 ppm. Engineering studies are in progress on chromium removal facilities.

REFERENCES

(*1*) KENTUCKY AIR POLLUTION CONTROL COMMISSION. Kentucky Air Pollution Control Commission Regulation, APCC–9, Ambient air quality, standards.

(*2*) KENTUCKY WATER POLLUTION CONTROL COMMISSION. Kentucky Water Pollution Control Commission regulation WP–4–1.

(*3*) OHIO RIVER VALLEY WATER SANITATION COMMISSION. Ohio River Valley Water Sanitation Commission (ORSANCO), Pollution control standard No. 70–1.

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